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THE NATURAL HISTORY OF THE MINERAL KINGDOM.

IN THREE PARTS.

PART I.

Of the Natural Hiſtory of the Strata of Coal, and of the Concomitant Strata.

PART II.

Of the Natural Hiſtory of Mineral Veins, and other Beds and Repoſitories of the precious and uſeful Metals.

PART III.

Of the Natural Hiſtory of the Prevailing Strata, and of the principal and moſt intereſting Phænomena upon and within the ſurface of our Globe.

By JOHN WILLIAMS, Mineral Surveyor, F. S. S. A.

IN TWO VOLUMES.

VOL. II.

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PART III.

Of the Natural Hiſtory of the Prevailing Strata, and of the principal and moſt intereſting Phænomena upon and within the ſurface of our Globe.

WHEN a gentleman takes a walk through his eſtate, or rides from home, he beholds various phænomena upon the face of the globe, which ſurpaſs his comprehenſion. In one place, he ſees the rocks diſpoſed in regular ſtrata, but when he advances a little way forward, that beautiful regularity is broken, and nothing appears but diſorder and confuſion.

Now, it appears to me very unaccountable, and much to the diſgrace of philoſophy, that we ſhould live ſo long upon the face of this globe, derive all our nouriſhment and all our conveniencies from it, and yet look upon the phænomena which it exhibits with an unintelligent gaze.

There is no room for this complaint in the other kingdoms of nature. A truly intelligent and ſucceſsful ſpirit of enquiry and reſearch has made great and wonderful progreſs in other branches of natural knowledge; but we are ſtill in a ſtate of infancy with regard to Mineral ſcience.

Many fine things indeed have been ſaid upon this ſubject by confident ſyſtematic theoriſts, and by ſtudious, but inexperienced philoſophers, which are diſproved by obſervation and experience. It may be held as a maxim, that extenſive and ſatisfactory knowledge of this ſubject is not to be gained at home.

Our powers are weak, limited, and imperfect, and the ſubject is vaſt, comprehenſive, and various; and therefore we cannot, in the retreats of philoſophic retirement, bring it near enough to examine facts. If we would wiſh to attain competent degrees of knowledge in the hiſtory of the mineral kingdom, we muſt ſurvey its territories, we muſt follow the example of eminent proficients in other branches of natural hiſtory, who take a ſmall portion of the ſubject of their enquiries at a time, and patiently examine all its parts piece-meal, by which method many uſeful and curious diſcoveries are made in the animal and vegetable kingdoms. I have in ſome meaſure followed this method in my hiſtory of the mineral kingdom; and as I have ſeen much, I ſhall ſtate a conſiderable number of facts, drawn from my own obſervation and experience, for the entertainment and inſtruction of the intelligent naturaliſt.

In the proſecution of this deſign, I will obſerve the following method.

I. I will take a general view of the prevailing rocks and ſtrata of this iſland, to ſee which of them are regularly ſtratified, and which of them are not, with the different degrees of ſtratification.

II. I will give the natural hiſtory of the ſtratification of our globe, of the bearing, ſlope, and continuity of the regular ſtrata, and of the fiſſures, chaſms, ſlips, and other interruptions of that regularity.

III. I will examine part of the modern ſyſtem of Count Buffon, &c. upon this ſubject, to ſee how it correſponds with the real ſtructure of the ſuperficies of our globe.

IV. I will treat of the natural hiſtory of mountains---of their interior and exterior ſtructure; and I will examine and explain the external phænomena of mountains, and of their glens and excavations; and I hope, that what I have to offer upon this ſubject will convey light and conviction to the intelligent and candid.

V. I will examine the nature, ſize, figure, and quality of the larger grains and fragments which are found in the compoſition of our rocks and ſtrata.

VI. I will ſelect ſome particular ſtrata for examination.

VII. I will offer a few obſervations concerning ſeveral other intereſting ſubjects relating to the mineral kingdom, among which is a treatiſe on Volcanoes.

In purſuing the method laid down, I am

I. To begin by taking a general view of the prevailing rocks and ſtrata of this iſland, to ſee which of them are regularly ſtratified, and which of them are not, with the different degrees of ſtratification. And I will begin with the whinny and the argillaceous regularly ſtratified mountain

tain rock, for no other reaſon but becauſe there is more of it found in Scotland than of any other kinds.

The regularly ſtratified mountain rock may be divided into ſeveral ſpecies or varieties, as,

1. Such as is found in regular ſtrata of middling thickneſs, ſtrong, hard and heavy, commonly of a black or blackiſh grey colour. This ſtone is generally mixt with grains and particles of quartz, ſhirl, and iron, though frequently in particles ſo ſmall and ſo well mixed as not to be viſible to the naked eye. This variety is common in many parts of Scotland, in high and low lands, and is called *whinſtone*, but though regularly ſtratified, it is frequently too hard and ſtrong to be commonly quarried for ruble-ſtones.

2. A ſort thinner bedded than the former, and ſeldom quite ſo hard; nevertheleſs, this variety is much of the ſame quality and colour; it is always regularly ſtratified, and commonly makes excellent ruble-ſtone for building.

There is a curious variety of this ſtone found in the Highlands, and in ſeveral places in the north and ſouth of Scotland, which may be called ſtreaked or ſtripped, each ſtratum of the rock being compoſed of ſeveral ſtrips of different colours,

lours, commonly white and black alternately, frequently white and grey, and ſometimes different ſhades of a lighter and darker grey. Some of theſe ſtreaks are not above the eighth part of an inch thick, and ſome are up to half an inch; but what is moſt remarkable of this ſtripping is, that the thinneſt of theſe ſtreaks ſpread out the whole breadth of the ſtratum of ſtone regularly, ſo that, when you ſee a clean ſection of one of theſe ſtones broke acroſs the bed of the ſtrata, theſe variegations have much the appearance of fine ſtripped cotton or other ſtuffs.

3. *Haſtle-whin*, or the indurated haſtle-coloured argillaceous ſtrata, of which there are conſiderable varieties; ſome of which have a fine cloſe uniform texture, thin bedded, and often containing diſtinct impreſſions of various ſmall plants between the laminæ or folds of the ſtrata, and ſome are of a more coarſe and grilly texture; and the coarſer ſorts are generally found in thicker beds than the former.

4. Aſh-coloured argillaceous mountain rock; ſome varieties of which are found more hard and ſtrong than the haſtle, and ſome more ſoft and tender.

This ſpecies or variety of the mountain rock is very common in many parts of the high and lowlands of Scotland; and it is generally diſpoſed in thin and very regular ſtrata.

5. Argillaceous ſtrata of a purple and a purpliſh brown colour, of which there is a great variety both in reſpect of quality and colour; ſome of it being indurated to a conſiderable degree; but much of the purpliſh argillaceous ſtrata are ſoft and tender, and of a marly texture, apt to decompoſe or diſſolve to clay when expoſed to the air and weather. With this ſpecies or variety may be ranked all the brown and reddiſh brown argillaceous ſtrata, of which there are great varieties; but as they differ little in quality and texture, and the diverſity of colour is endleſs, I reckon, that it would be as uſeleſs as it would be difficult to enumerate them all; but they are generally all regularly ſtratified.

6. Blue, purple, aſh-coloured, and grey ſtrata, of a fine ſmooth grain, and of a ſlaty or laminated texture. The ſlate rocks are generally compoſed of fine particles, and theſe particles are as finely put together, the ſtrata of them being extremely regular, and of a fine laminated ſtructure, eaſily ſplit or cloven with the grain, yet ſo ſtrong, as with difficulty to be broken tranſverſely to the bed of the ſtone. We may reckon, that the ſlate rocks are ſtratified in the higheſt degree of

perfection;

perfection; and from the finely laminated texture of the ſtrata, they cleave ſo thin and regular as to make a light durable and elegant covering for our houſes. The fine blue ſlate of Eſdale and Ballachyliſh, in the Highlands of Scotland, are well known, and the blue ſlate of Stobo in Tweedale is alſo well known; but there is a fine purple ſlate rock near Tombay, above Callender in Monteith, which is not ſo commonly known. This is a plentiful ſlate rock of excellent quality, and of a rich purple colour, which makes a moſt elegant and beautiful roof; but only a little of the looſe and ſhattery ſurface of this rock has been worked.

They have not opened the quarry to any depth to get good and ſolid ſlate.

Theſe ſlates may be carted to Stirling-Bridge, and then conveyed by water to any part of Britain.

7. Plate and ſchiſtus, of which there is a great variety, and a great quantity in many of our mountains and valleys. Some varieties of the ſchiſts or ſhivers are of the ſame colour and quality as the ſlates, the only diſtinguiſhable difference being in the ſtratification. The ſtrata of ſlate are found as regular and as finely laminated as ſtone can be; but the plates and ſhivers on the contrary frequently exhibit nothing but a

confuſed irregular maſs; ſome of it as if it were half ſtratified, and a great deal of it without the leaſt appearance of ſtrata; and when there is an approach to regular ſtratification, it is to be obſerved, that the ſtone itſelf approaches to the quality of ſlate. I obſerved before, that there is more of the argillaceous than of any other particular ſpecies of rock appearing in this country; and, among the varieties of it, the ſchiſtus is the only one that is not very regularly ſtratified.

There is a great variety of the ſchiſtus, both in colour and texture, which is not ſtratified at all. Some of theſe are found in prodigious thick beds of a friable texture, appearing like an indigeſted maſs, frequently containing balls and irregular maſſes of highly indurated ſtones of various ſizes and colours. Some of the ſchiſtus are of a platy texture, ſeparating into ſmall thin ſcales and glazed maſſes of various ſizes, all of them thin at the edges, with an oily or ſlippery ſmoothneſs to the ſight and in handling. Again, ſome of the beds of ſchiſtus appear in a thick homogeneous formleſs maſs, without any intermixture of balls or other hard maſſes, and ſome of it contains ſmall maſſes of pyrites, quartz, &c. and I have ſeen much of the half or imperfectly ſtratified ſchiſtus in extenſive rocks, containing conſiderable quantities of fine quartz in diſcontinuous veins or ribs, and in miſhapen maſſes of various ſizes. This variety of the ſchiſtus is frequently pretty hard, and ſome ſtrong beds of ſtone are often found in the beds of it; and where it is mixt or ribbed with quartz, it is not uncommon to find ſome maſſes of lead ore in it. I have frequently ſeen ſmall quantities of lead ore in rocks of ſchiſtus in the Highlands of Scotland, &c. but I never ſaw it continue or come to any thing upon trial. I have ſeen great quantities of black ſchiſtus which had a very oily appearance, ſome of which will actually flame, but not conſume in the fire. Part of the oily or inflammable ſchiſtus is of a ſcaly platy texture; and I have ſeen ſome of it very hard, and naturally ſeparating into ſmall irregular maſſes of various ſizes and ſharp angles. But it would be both tedious and uſeleſs to enumerate all the varieties of the ſchiſtus which I have ſeen as to colour, quality, and diſpoſition of the beds.

Secondly, Granite rocks. The granite is a ſtrong, hard, and heavy ſtone, of an irregular texture, compoſed of grains and fragments of various ſizes, quality, and colour, of which there are ſeveral ſpecies which I have ſeen, ſuch as,

1. Elegant reddiſh granite or porphyry of a gellied texture, in which the pale-roſe, the bluſh, and the yellowiſh colours are finely mixt and

ſhaded. This is one of the fineſt and moſt elegant ſtones in the world. The mountains of Bineves in the Highlands of Scotland are chiefly compoſed of this ſtone, and it is found in great abundance in many other parts of Scotland; but I never ſaw this variety exhibit the leaſt appearance of ſtratification.

2. Fine reddiſh granite, in which it may rather be ſaid, that the ſame colours are blended together than ſpread out with ſuch finely ſhaded tints as the former. I have not ſeen this variety of the granite ſtratified; on the contrary, both theſe exhibit ſuch a degree of uniform regularity, that in ſome places there is no difference between a ſtone and a mountain, excepting only in magnitude, as many mountains of granite are nothing but one regularly uniform maſs throughout, in which not the leaſt mark of a bed is to be ſeen, nor hardly a crack or fiſſure, unleſs it be at the edge of ſome precipice or declivity. Theſe two varieties of elegant red granite are frequently met with in the Highlands and Lowlands of Scotland, in Galloway, and many other places. We often find maſſes of talc ſo large in this ſecond variety, that ſome of them may be called fragments, not diſpoſed in any order, but higgledy-piggledy throughout the body of the ſtone.

3. Stratified reddiſh granite, reſembling the ſecond in colour and quality, but not always quite ſo pure or free from admixture of other ſtony matter of a different quality. This variety of the granite frequently contains larger and ſmaller fragments of fine laminated talc. I have ſeen this granite diſpoſed in pretty regular ſtrata in the ſhires of Moray and Nairn, and other parts of Scotland.

4. White and whitiſh granite, generally of a looſe granulated texture, containing a great quantity of mica, or ſmall leaved talc, and the grains of quartz ſometimes large and angular. This variety of granite is apt to weather and decompoſe, and part of it frequently diſſolves, and the diſſolution often falls to a ſediment in lakes, ſo fine and light, as rather to hang ſuſpended in the middle, and near the bottom of the water, than to ſink in it. I have found this ſubſtance in many places, where water had been accidentally drained off, reſembling fine ſhell-marl, only much lighter. When thoroughly dry, it is the lighteſt foſſil ſubſtance I ever handled, and when blanched with rain, it is as white as ſnow. This variety of granite, either not ſtratified, or exhibiting thick irregular beds. It frequently contains a conſiderable quantity of talc, in maſſes and ſcales too large to be called mica.

The ſediment which is found in lakes from the diſſolution of the white granite, if perfectly free of ferruginous matter, is reckoned an excellent ingredient in the compoſition of fine china or porcelain ware. It is highly probable that this curious foſſil is the kaolin of the Chineſe.

The authors of the Hiſtory of China inform us, that the fine porcelain ware of China is compoſed of two different foſſil ſubſtances, called by them *petuntſe* and *kaolin*. We are further told, that the petuntſe is a fine white vitreſcible ſtone, compact and ponderous, and of conſiderable brightneſs in the inſide when broken, which they grind to a fine powder; and that the kaolin is not a ſtone, but a fine white earthy ſubſtance, not vitrifiable, at leaſt not in the common heat of a potter's furnace: That they mix the kaolin and the flour of the petuntſe together, and form a paſte of this mixture, which they mould into all ſorts of porcelain veſſels.

Now, from the beſt accounts of this matter which I have been able to obtain, after a good deal of ſearch and enquiry, it appears to me, that the ſediment, which I have mentioned above, is the true kaolin; and that as the fine white glaſſy quartz, which is found in irregular maſſes, and in irregular diſcontinuous veins or ribs, in ſome of the rocks of ſchiſtus, is the true petuntſe; and if this obſervation is really true, it deſerves to be remarked, that Scotland is as well furniſhed with the beſt materials for making fine porcelain as moſt countries in the world. The ſpecies of quartz, which I ſuppoſe to be petuntſe, is of a pure fine uniform glaſſy texture, ſemi-tranſparent, and of a pure ſnowy whiteneſs. A broken piece of this ſtone, and a newly broken piece of fine porcelain, are very like one another. Theſe hints are of ſuch importance, that they deſerve further enquiry, and a proper courſe of experiments to aſcertain the fact, whether or not theſe foſſils poſſeſs the real properties of the petuntſe and kaolin.

If the iſland of Britain contains this valuable treaſure, it ought not to lie buried for want of attention and induſtry. There is a great quantity of petuntſe, or pure white quartz, in many parts of Scotland, particularly in the north and Highlands. There is a conſiderable quantity of it upon the ſhore, and waſhed by the tide, between Banff and Cullen, generally in pretty large maſſes in rocks of bluiſh ſchiſtus, and, to the beſt of my memory, it is very fine of the kind. There is alſo a conſiderable quantity of it in maſſes and diſcontinuous ribs, in rocks of blue ſchiſt, about three or four miles north of Callendar, in Monteith, upon the ſide of the high road, which runs parallel to Lochleodunich, which I alſo think very fine.

In ſome places this ſort of quartz is tinged with a fleſh colour from the neighbourhood of iron, which renders it unfit for porcelain; but there is plenty to be found of a pure white, in almoſt all parts of Scotland, without any mineral tinge whatever.

The kaolin is perhaps as plenty in Scotland as the petuntſe, there being many extenſive lakes eaſily drained, which contain a conſiderable depth of it; and moreover, it is to be found in many places that have been lakes, which are now laid dry by accident. There is a quantity of kaolin about a hundred yards below the public road, upon the ſouth ſide of a bridge about a mile and a half or two miles ſouth of the inn of Aviemore in the Highlands. It lies beneath a ſtratum of peat-bog, in a place which has been a lake, but is now drained by the river Spey cutting through one ſide of the mound which formed the lake. I think this ſample very fine and pure, excepting that ſome parts of it may be a little diſcoloured by a light earthy ſediment which lies above it. There is more than one ſtratum of the kaolin in this place, and ſome of it is exceeding white, eſpecially when blanched by the rain; and there is a white granite rock up the rivulet, at ſome diſtance above the bridge, the decompoſition and diſſolution of which is ſuppoſed to produce this fine and curious ſediment.

Several lakes in the Highlands of Scotland are nearly full of kaolin. I will at preſent only point out one of them, which is ſituated in the country of Stratherig in Inverneſs-ſhire, leſs than a mile north of the public road, and upon the weſt ſide of the farm of Drimin. It is a pretty long lake, the name of which I do not now remember. There is a conſiderable depth of kaolin in this lake, which may be drained at a moderate expence, and if I remember well, the granite rocks which ſurround it are pretty white and fine. It ſhould be remarked, that if the kaolin originates from coloured granite, it is good for nothing, eſpecially if it contains the leaſt tinge of iron, becauſe this will diſcolour and ſpoil the beauty of the porcelain; but wherever white granite is found compoſed of quartz, feldtspath, and mica, without any admixture of ſhirl, and eſpecially of iron, the kaolin ſhould be diligently ſought after in that neighbourhood.

I have been informed that Lochdoon in Galloway contains a great quantity of kaolin. This lake was drained ſome years ago, in the view to lay dry the ſhell-marl it was ſuppoſed to contain, which, however, upon trial, turned out to be kaolin. The one ſubſtance may very eaſily be miſtaken for the other, as at firſt ſight they are both very like the ſame; but they may be diſtinguiſhed with certainty, by trying both with acids. Shell-marl will ferment ſtrongly in weak vinegar, whereas, pure kaolin will not ferment at all in ſtrong aquafortis. I have not ſeen Lochdoon, and therefore, I can ſay nothing about the granite of that neighbourhood.

5. Grey granite or moor-ſtone, ſo called in Cornwall, compoſed of black and white grains of various ſizes. This ſtone is very common in many parts of this iſland, both in high and low lands, north and ſouth. In ſome places it ſhews no marks of ſtrata, and in others it is diſpoſed into thick irregular unwieldy beds, which are commonly broken tranſverſely into huge maſſes or blocks of various ſizes and ſhapes.

There is a great variety of the grey granite, as well as of all other rocks. Some varieties of it differ but little in appearance or quality from ſome ſpecies of the baſalts. Others are compoſed of almoſt equal quantities of black and white grains, about the ſize of ſmall peaſe, whence it is called Peaſy-whin by many Scotch maſons. I have ſeen the grey granite, in Galloway and other places, exhibit a longitudinal grain or texture, as if the component parts had been all moved one way by a gentle flow of water.

When the grey granite begins to weather or decompoſe, which it often does at the outſkirts of the rock, we can then examine its component parts, and we find ſome of it contain pretty large grains of a cubic, a rhomboidal, and other figures, and ſome of them ſo large as to deſerve the appellation of fragments, and the largeſt fragments are always of quartz or feldſpath, and of talc.

We meet with a great variety of colours, as well as quality and texture, of the grey granite. Some of it appears of a very light grey, and ſome of a very dark or blackiſh grey colour; and it is found of all the intermediate tinges or ſhades between theſe extremes.

6. Grey compoſite granite, the texture of which, when broken, looks as if compoſed of ſmall fragments of various ſizes and ſhapes, not unlike calveſhead-gelly. When this ſtone is poliſhed, the grains or fragments being all fine, they appear as if they were ſet or inlaid in a fine water-coloured pellucid matter. This is a moſt beautiful ſtone, but it is ſo long ſince I have ſeen any of it, that I do not now diſtinctly remember all its phænomena.

7. There is in ſome parts of Britain an imperfect granite of a looſe friable texture, which is apt to weather, decompoſe, and be reduced to granite

gravel. There is a remarkable rock of this ſpecies near the Queen's-ferry in Scotland, on the road to Edinburgh, which appears in prodigious irregular thick ſtrata.

This rock produces excellent materials for the high roads, and ſeems to be chiefly compoſed of quartz, ſhirl, and ſome iron.

8. There is a ſingle ſtratum of very curious compoſite granite, a little to the weſt of Loſſymouth, in the county of Moray in Scotland, of about ſix or eight feet thick. This ſingular ſtratum is compoſed chiefly of grains and fragments of various bright and elegant colours, many, or moſt of which, are as large as peaſe and beans, and they are all fine, hard and ſemi-pellucid; and it is very remarkable, that there is about an eighth part of good lead ore in the compoſition of this ſtone, of the ſpecies commonly called potters-ore; and it is alſo remarkable, that there is no other granite in that neighbourhood but this ſingle ſtratum; all the ſtrata above and below it being moſtly a coarſe, imperfect, grey ſand-ſtone.

9. There is alſo in many parts of the north, and Highlands, and in Galloway, an excellent ſpecies of grey granite, compoſed chiefly of red and black coloured grains. This is a fine, ſtrong

and durable ſtone, very fit either for maſſy or for ornamental architecture.

Thirdly, Limeſtone, which may be divided into the following ſpecies:

1. The grey, whitiſh, and pure white, regularly ſtratified, mountain limeſtones, of a granulated texture, broad bedded and ſtrong, much uſed for building bridges in the north and Highlands of Scotland. Some of this ſtone breaks like coarſe iron, but more of it like a ſugar loaf, and I have ſeen much of it in the Highlands as white as the pureſt refined ſugar, which may be called Parian marble; and ſome of it compoſed of fine glittering ſpangles as large as the ſcales of fiſhes.

2. Coarſe-looking grey mountain limeſtone, of a granulated texture, hard and ſtrong, and difficult to work, exhibiting in ſome places a tumulous and unequal, in others a ſmooth and regular ſurface, and ſometimes appearing on the ſides of the mountains and lower moors, when the ſoil is waſhed away, like large ſheets of dirty ice.

In ſome places this ſtone appears regularly ſtratified, in other places nothing appears but one vaſt irregular bed or rock, of very unequal thickneſs.

3. Aſh-coloured mountain limeſtone, compoſed of very ſmall grains or particles of a fine ſmooth uniform texture, when broken, reſembling flint. I have ſeen, in ſeveral parts of the Highlands, hills of this ſtone; ſome of which exhibit regular ſtrata, and in other places, it appears in one great maſs or ſediment, like the granite rocks. In the iſland of Iſla, and in the country of Aſſint in the Highlands, and ſeveral other places, this ſpecies of limeſtone exhibits an unequal jagged ſurface. Theſe jaggs are ſharp pointed, very hard and cloſe to one another, and ſome of them a foot or a foot and a half long, which makes it both difficult and dangerous to walk upon this rock.

4. Regularly ſtratified limeſtone, found in the low countries, of which there is an endleſs variety of colours and textures not eaſily deſcribed, as grey, blue, black, brown, red, purple, and aſh-coloured, with mixtures, tinges, and varieties of all theſe colours; and theſe are found of all degrees of hardneſs and purity, and reſembling almoſt every other ſtone.

5. Limeſtones accompanying the coal metals, and frequently the immediate roof of coal. Of theſe there is a great variety, in quality, colour, and texture, and there is as great a variety

in the degrees of purity, ſome of them being ſo debaſed with clay and other heterogeneous matter, that it is good for nothing, and others as rich and fine as any lime in the world. The limeſtones of the coal countries are always found in regular ſtrata, and the ſtrata of theſe ſtones are more regular in the line of bearing than any other ſpecies or diviſion of them that have come under my notice.

I have ſeen many other limeſtones ſwell out in ſome places to a prodigious thickneſs, ſo as to cover a large extent of ſurface; and where rivers ran acroſs them, the deepeſt glens did not cut through the limeſtone; notwithſtanding, in advancing forward upon the line of ſtretch or bearing of the ſtrata, I have ſeen a lime rock, which is in ſome places ſeveral hundred yards thick, dwindle away until it was cut by water, further forward, where it was not above two yards thick, and in ſome places it could not be ſeen at all; nevertheleſs, it would appear again and again ſtill forward in the proper line. But this is not the caſe with the limeſtones of the coal countries. Theſe are found as regular as the coals which they accompany, and the coal ſtrata are more regular in continuation upon the bearing, as far as the claſs of ſtrata belonging to the coal reaches, than any other that I have inveſtigated;

gated; and I look upon it, that this obſervation may be of uſe in practice.

The maſon and the farmer may wiſh to find a known limeſtone at ſome diſtance from the place where it is ſeen. Let them keep the line of ſtretch or bearing of the ſtrata, and in the coal country they will be ſure to diſcover it at nearly the ſame parallel diſtance from a ſeam of coal or other given ſtratum, as at the place where it was laſt ſeen. But many of the mountain limeſtones are not ſo much to be depended upon. Though you may have a good and plentiful quarry in one place, yet, perhaps half a mile, or half a quarter of a mile further forward, you cannot diſcover it, and becauſe it is not to be diſcovered; it is dwindled away to nothing, and yet it will appear again farther forward; which makes the mountain limeſtones uncertain to be diſcovered where you do not ſee them; as theſe rocks very frequently grow thicker and thinner, and ſometimes ſqueeze out to nothing; and I comprehend under this denomination all the limeſtones not found accompanying the coals and coal metals.

I have obſerved above, that the limeſtones of the coal countries are always regularly ſtratified; ſome of which ſtrata are very thick, others very thin, and they are commonly found of all the intermediate thickneſſes.

The limeſtones of the coal fields are often diſtinguiſhable, by containing a great variety of ſhells, coral, and other marine bodies, which are found blended in the heart and compoſition of the ſtone.

6. Marbles of various colours, figures, and degrees of beauty and goodneſs. Some of theſe are found regularly ſtratified in layers of middling thickneſs, but they are oftener met with in thick irregular beds, which are generally broke tranſverſely into blocks and pillars of various ſizes, from one thick unwieldy ſtratum. Among theſe, the fine white ſtatuary marble of Aſſint in Sutherland, is the pureſt and beſt I ever ſaw. I am perſuaded there is none better, if any ſo good, in all Europe, and there is enough of it to ſerve all Britain, perfectly ſolid and pure, free of any blemiſhes, flaws, or ſtains, and blocks or ſlabs of any ſize may be cut out; but there is bad acceſs to it, nor would it be eaſily quarried, there being a little cover above it, of a ſoft looſe whitiſh limeſtone.

This marble accompanies a prodigious rock of grey limeſtone of a granulated texture, which appears in regular ſtrata at Aſſint; but it is one of thoſe which varies in thickneſs, as you advance along the bearing of the ſtrata.

The good white marble of Aſſint is only to be ſeen in the bed of the river, near a conſiderable houſe, a mile or two ſouth of the church; but I cannot remember the name of the particular place.

It is a ſingular loſs to the arts, eſpecially to ornamental architecture, that men of fortune are not generally naturaliſts, at leaſt, ſo far as to be acquainted with the peculiar diſtinguiſhable characters, qualities, and excellencies of the finer ſtones, and to be able to judge which is beſt for their particular purpoſes; and not to be obliged, as they generally are, to leave it to the caprice or intereſt of the ſtone-cutter, to chuſe for them, who is naturally ſuppoſed to ſtudy his preſent eaſe and advantage, more than the duration and future beauty of the piece.

When men of rank and fortune attend to the progreſs and encouragement of the arts, they are ſure to arrive at conſiderable degrees of perfection in any country. Ancient Egypt, Babylon, Greece, and Italy, are ſo famous for their great works in ornamental architecture, for the rare qualities of their materials, and the excellent workmanſhip of ſome remains of antiquity, that they have been the wonder of many ages, and they ſtill continue to be admired. It has many times vexed me to reflect, that our wealthy people and eminent artiſts ſhould ſend to foreign countries, for ſtones for ornamental architecture, when, perhaps, no country can produce ſo great a variety of the moſt excellent ſtones for that purpoſe as are to be found in Great Britain; and, therefore, in caſe poſterity ſhould grow wiſer, I will point out a few of the places where I have ſeen ſingularly excellent ſtones, moſt of which are fit for any thing that ever was done in ſtone in any part of the world.

The firſt that I will take notice of are ſome excellent marbles.

1. A few miles from Blairgowrie in Perthſhire, not far from the high road ſide, towards the north, there is an excellent, granulated, broad-bedded limeſtone, of a ſugar loaf texture, and as white as the fineſt ſtatuary marble; I look upon this to be a good ſpecies of the true Parian marble of the ancients; and as it may be eaſily raiſed in blocks and ſlabs perfectly free of blemiſhes, is uniformly of a pure white, and free and eaſy to be worked in ſtatuary and other ornamental architecture, I think it only requires to be well known and brought into uſe, to become of great value.

2. There is ſome of this ſpecies of ſtone in the Duke of Gordon's lands, in the foreſt of Glenavon, compoſed of fine glittering broad grains like ſpangles, as large as the ſcales of fiſhes, but the ſituation is remote, and difficult of acceſs.

3. The fine white ſtatuary marble of Aſſint in Sutherland. The marble of Aſſint has a juſt title to an eminent rank among peculiar and excellent ſtones; and although I pointed out that marble in my general view of the limeſtones of Scotland, I will take the freedom to repeat here, that it is the whiteſt, the pureſt, and beſt that ever I ſaw: That there is none better, if ſo good, in all Euorope: That blocks and ſlabs of any ſize may be cut out perfectly ſolid and pure, free from any flaws or blemiſhes whatſoever: That there is enough of it to ſerve all Britain, and much more; but there is bad acceſs to it; nor would it be eaſily quarried, being ſituated in and under the bed of a ſmall river, with ſome cover above it of a looſe, ſoft, white limeſtone.

This excellent ſtone is of the pureſt white, and of a fine ſmooth uniform texture in the inſide, of a bright appearance when broken, and of ſo fine and pure a quality, that the edges of a fragment are ſemi-tranſparent. In ſhort, this is a very ſuperior marble; but I am afraid, that the real beſt quarry is only known to myſelf. It is only to be ſeen in one place in the river, the reſt of it covered with the white ſhattery limeſtone mentioned above. It is now twenty years ſince I viſited that country, ſo that I have forgotten the particular name of the place. But a gentleman (I think Mr M'Kenzie of Ardloch) lived then in a large houſe near this marble, fine maſſes of which were to be ſeen in his office-houſes. The marble is in the bed of the river, not far to the northward of that houſe.

4. Near the farm-houſes upon the north ſide of the ferry of Ballachyliſh in Lochaber, there is a limeſtone or marble rock, of a beautiful aſhen-grey colour, and of a fine regular uniform grain or texture, capable of being raiſed in blocks or ſlabs of any ſize, and capable of receiving a fine poliſh.

This ſingular rock is finely ſprinkled throughout with grains and ſpecks of fine bright mundick or pyrites, and likewiſe with grains and ſpecks of beautiful lead ore of a fine texture, which to the eye appears to be rich in ſilver. This would make a bright and beautiful metallic marble.

5. In the farm of Blairmachyldach, about three miles ſouth of Fortwilliam, in the bed of a

river, there is a very ſingular marble, conſiſting of a black ground, and flowered with white. This ſtone is of a fine cloſe grain or uniform texture, but not very hard, and the flowering in it is light, elegant, and beautiful, like fine needlework, or rather reſembling the froſty fret work upon glaſs windows in a winter morning; and this flowering is not only upon the outſide, but quite through all parts of the body of the ſtone.

Secondly, Jaſper, of which there is an extenſive rock, near Portſoy in Banff-ſhire; ſome parts of that rock contain a beautiful mixture of green and red, &c. which appear finely ſhaded and clouded through the body of the ſtone when poliſhed. I ſaw chimney-pieces of this ſtone in the old ruinous houſe of the Boyne in that neighbourhood, in which a conſiderable portion of red, or fine roſe or bluſh-colour, is ſhaded with the green, and ſpread out in beautiful clouds through all parts of the ſtone. Theſe jambs and lintels were exceeding beautiful, and retained the luſtre of their poliſh undecayed. This would be a valuable jaſper quarry, if properly opened; but as the body of the rock is hard and ill to work, I have ſeen no good ſamples of it, excepting the above-mentioned old jambs. Ill-choſen imperfect blocks are torn off from the outſide of the rock, which hurts its reputation. I have ſeen fine rock there of great beauty, but I never ſaw any of it quarried, nor can it be quarried without ſkill and expence.

Thirdly, Agate. There is a large patch of fine agate upon the ſide of a hill near the church of Rothes in Moray, chiefly of a fine mixture of the red and white colours.

This is a very beautiful patch of rock. It is very hard and heavy, of a fine ſmooth uniform texture, and of conſiderable brightneſs, in which the red and white, &c. are remarkably clear, and finely mixt and ſhaded through the ſtone.

This is the largeſt and moſt beautiful agate rock I ever ſaw, and ſo fine and hard as to be capable of the higheſt luſtre in poliſhing.

Fourthly, Porphyry, of which a great part of the hill of Bineves in Lochaber is compoſed. The porphyry of Bineves is a remarkably fine beautiful and elegant ſtone of a reddiſh caſt, in which the pale-roſe, the bluſh, and the yellowiſh white colours, are finely blended and ſhaded through the body of the ſtone, which is of a gelly-like texture, and is, undoubtedly, one of the fineſt and moſt elegant ſtones in the world.

About three-fourths of the way up this hill, upon the north-weſt ſide, there is found a porphyry of a greeniſh colour, with a tinge of a browniſh red. This ſtone is ſmooth, compact, hard and heavy, of a cloſe uniform texture, but of no brightneſs when broken. It is ſpotted with angular ſpecks, of a white quartzy ſubſtance.

Fifthly, Granite, which, with the granite-like porphyry above-mentioned, I reckon the glory of all ſtones, as all the beauties and excellencies of all other ſtones of mixed colours, are moſt eminently contained in theſe. The finer and moſt elegant red granite, and the fineſt granite-like porphyries, are ſo near a-kin to one another in quality and appearance, that I will not attempt a diſtinguiſhable deſcription of them. Scotland is remarkable for a great number and variety of granites, of which I have given ſome account in my general view of the prevailing rocks of North Britain; and I believe, I may venture to ſay in favour of many Scots granites, that the world cannot produce any more excellent in quality and beauty.

The elegant reddiſh granite of Bineves, near Fortwilliam, is perhaps the beſt and moſt beautiful in the world; and there is enough of it to ſerve all the kingdoms of the world, though they were all as fond of granite as ancient Egypt.

There are extenſive rocks of red granite, upon the ſea-ſhore, to the weſt of the Ferry of Ballachyliſh, in Appin; and likewiſe at Strontian, as well as many other parts of Argyle-ſhire. I have ſeen beautiful red granite by the road ſide, north of Dingwall, and in ſeveral other parts of the north of Scotland, which had been blown to pieces with gun-powder, and turned off the fields. There are extenſive rocks of reddiſh granite about Peterhead and Slains; and both of red and grey granite in the neighbourhood of Aberdeen. The hill of Cruffel in Galloway, and ſeveral lower hills and extenſive rocks in that neighbourhood, are of red and grey granite, where there are great varieties of that ſtone, and many of them excellent.

Upon the ſea-ſhore, near Kinedore, weſt of Loſſiemouth in Moray, there is a bed of ſtone about eight feet thick, which I think ſhould be called a compoſite granite. This ſingular ſtratum is compoſed of large grains, or rather ſmall pieces of various bright and beautiful ſtones of many different colours; and all the ſtony parts are exceeding hard, and fit to receive the higheſt poliſh; but what is moſt ſingular, about a ſixth or eighth part of this remarkable ſtratum is good clean blue lead ore, of the ſpecies called potter's ore.

I know that the ſeparate ſtony parts compoſing this ſtratum are all hard, fine, and ſolid, and capable of the moſt brilliant poliſh; but I do not now remember whether or not ſolid blocks of it can be raiſed perfectly free from all cracks and flaws. If they can, I imagine, from the beauty and variety of the colours of the ſtony parts, and the great quantity of bright lead ore, which is blended through the body and compoſition of the ſtone, that this would be a very curious and beautiful ſtone when poliſhed.

Sixthly, Baſalts, of which there is a very great variety of the grey kinds in many parts of Scotland, and ſome of them are capable of the brighteſt poliſh. There is a good black ſtone of this ſpecies, formed into large columns, upon the ſouth ſide of Arthur's Seat, near Edinburgh, of a fine uniform texture, and a good black colour, and capable of receiving a very high poliſh. This ſtone would be peculiarly fit for all ſorts of ornaments about ſepulchral monuments. It will poliſh to a bright and beautiful black, which will be unfading.

I ſhall now proceed to the ſeventh diviſion of limeſtone, which is,

7. Stone-marle, or ſoft limeſtone, commonly found within regular ſtrata, and of all the colours of other ſtones. I have ſeen of the ſtone-marles red, brown, purple, haſle, grey, bluiſh, aſh-coloured, and white, and ſome of them more variegated than any Caſtile ſoap.

The greateſt quantity of the ſtone-marle diſſolves upon the land in a few weeks, or at fartheſt, in the courſe of a ſeaſon ; but there are found in ſome ſtone-marle pits particular ſtrata, ſo hard as not to diſſolve upon the land at all, without burning it into lime ; and yet, immediately above and below theſe hard beds, the marle is ſoft enough to diſſolve in a ſhort time.

8. Chalk, ſome of which is regularly ſtratified, and there is a great deal of it appears in thick irregular maſſes, like ſediment ; but as it is now a long time ſince I was in the chalk countries, I do not pretend to be able to give a perfect account of this remarkable calcareous foſſil. I have ſeen fine white indurated chalk brought from Ireland for burning into lime, in which the flints are promiſcuouſly blended, as in the common chalks of England, the maſſes of which appeared to me to be broken off from regular ſtrata when quarried.

Fourthly, The micaceous mountain rock, which is of a blackiſh and dark grey colour, hard and heavy, of a longitudinal texture, is exceedingly ſtrong and difficult to break acroſs the grain. This ſtone contains particles of quartz, ſhirl and pyrites, frequently of iron, and commonly holds ſo much mica in the compoſition of the ſtone, as gives it a bright metallic appearance. There are extenſive mountains of this ſtone in many parts of the Highlands, and in Galloway. It generally appears in pretty thick ſtrata, which naturally break into flattiſh glebes of various ſizes, but generally all very large.

Fifthly, Baſalts, which abound in Scotland, of which a conſiderable quantity was carried from the Frith of Forth to London, for paving the ſtreets. This remarkable ſtone is very ſtrong, hard and heavy, of black or blackiſh grey, and all degrees or ſhades of the grey colours. Sometimes it is pretty fine in the inſide, but more commonly of a coarſe granulated texture, and ſome of it bright in the inſide, when broken. The principal parts in the compoſition of this ſtone are grains of different ſizes of quartz and ſhirl, as appears by the black and white glittering particles in it; and it commonly contains ſome iron.

This ſtone always appears in thick irregular unwieldy beds, and is found in many parts of Scotland, in high and low lands, in the iſles and coal countries. Some of the beds of baſalts are of enormous thickneſs; and where no other ſtrata are found above, it is ſeldom of equal or regular thickneſs: On the contrary, where it is found uppermoſt, it often ſwells into little hills of various ſizes. Moſt of the ſmall iſlands in the Frith of Forth, are rocks of this ſtone; and ſeveral hills in the neighbourhoods of Inverkeithing and Edinburgh, are formed of thick beds of baſalt, ſuch as Arthur's Seat, &c.

This ſingular rock may be divided into ſeveral ſpecies or diſtinguiſhable varieties, both with reſpect to the external figure it aſſumes, and to the internal grain or texture of the ſtone.

The moſt diſtinguiſhing characteriſtic of the baſalt is this,—it aſſumes various figures, ſuch as columns, glebes, balls, &c.

As to the *firſt* of theſe: The columnar baſalts are frequently found formed into pillars of various ſizes and lengths, having five, ſix, and ſeven ſides; but columns of a quadrangular figure are not common. Theſe columns are all ſmooth on the outſide, and lie parallel and contiguous to one another, ſometimes perpendicular, and often inclining in proportion to the poſition of the ſtratum which is thus divided: If the ſtratum lies horizontal, the columns are perpendicular; if inclining, the pillars alſo incline in exact proportion to the declivity of the ſtrata, they being always broke right a-croſs the ſtratum.

Some of theſe pillars of various lengths are only one entire piece from top to bottom; others are divided by one or more joints or pieces laid upon one another, which form a column of ſeveral

ral parts. The rock called the Giant's Cauſeway, in Ireland, as it is deſcribed, is a pretty good ſpecimen of the jointed columnar baſalts; but there is a more beautiful and more regular ſpecimen of it lying above Hillhouſe lime-quarry, about a mile ſouth of Linlithgow, in Scotland; and a coarſer one near the toll-bar north ſide the Queen's-ferry, and in ſeveral other parts of Fife.

The baſalts in ſome places is formed into magnificent columns of great length; and in other places exhibiting an aſſemblage of ſmall and beautiful pillars, reſembling a range of balluſtrades, or organ pipes. Some very long columns appear on the ſouth ſide of Arthur's Seat, near Edinburgh; and there are ſeveral magnificent columns of great length, in the iſland of Egg, and many other places.

The columnar baſalts, when broken, are frequently black, or of a blackiſh grey colour in the inſide. Some of it is compoſed of ſmall grains or particles, which gives it a tolerably ſmooth and uniform texture; and much of it holds larger grains in the compoſition, of a rough, ſharp, and unequal ſurface in the fracture. But all the grains are fine, hard, and bright; and as the ſtone is compact, it is generally capable of receiving a very fine poliſh.

2. The ſecond ſpecies or variety of the baſalts I will take notice of, is not formed into columns, but into glebes of various ſizes and figures, ſome of which are nearly quadrangular, or of a flattiſh ſquare, with obtuſe edges, and ſome of it aſſumes a round, an oval, an oblong, and ſeveral other figures; and theſe maſſes are found of all ſizes, from the bigneſs of an egg to the ſize of a houſe. Although theſe ſtones differ from the columnar ſpecies in figure, they nevertheleſs have an exact reſemblance in almoſt every other reſpect. The colour, quality, and internal ſtructure is the ſame; and they are equally ſmooth on the outſide, having all the edges rounded off; and they are equally ſtrong and hard.

In ſhort, the only diſtinguiſhable difference is the external figure, ſo that I think they can only be reckoned as varieties of the ſame ſpecies of rock.

It appears to me very evident, that this ſtone was broken and ſeparated into this great variety of figure and ſize, by the chapping of the maſs of matter, while the rocks were ſoft and humid, before induration was completed, by the ſtony matter ſhrinking into leſs room, as the moiſture was draining off by evaporation, and otherwiſe.

The inequality of the ſides of the columnar baſalts, and of the ſize and figures of the glebous, is to me a clear proof of their being firſt formed by the cracking of the ſtratum, while the humidity was exhauſting.

It is a very common thing to ſee one ſtratum of the baſaltine rock exhibiting in one place regular pillars or glebes, and near them very irregular ones, differing little from the common cutters which are found in all rocks; and at no great diſtance, the ſame rock is found run together into one entire maſs, exhibiting no tendency to be broke or divided into any diſtinguiſhable figure whatever. This obſervation is verified in the ſtratum of baſalt, which is formed into pillars on the ſouth ſide of Arthur's Seat, near Edinburgh, as well as in many other places I have ſeen, which makes it evident to me, that the formation of ſome part of ſuch rocks can proceed from no other cauſe but the loſs of humidity.

Some of theſe rocks only produce ſolid maſſes of different figures and ſizes, and others produce different quantities of a ſofter friable ſtony matter, of the ſame quality in which the hard maſſes of different figures are found imbedded.

Pretty good ſpecimens of the ſecond ſort of baſalts are to be ſeen by the road ſide, between Cramond bridge and the Queen's-ferry, and in ſeveral other places in the Lothians and Fife.

3. Cruſtated baſalts, which is not only formed into glebes and maſſes of various ſizes, imbedded

in a leſs or greater quantity of the ſofter friable matter mentioned above; but theſe maſſes are alſo cruſted round with ſeveral coats of the ſame baſaltine matter, though theſe ſeveral cruſts are in ſome degree more looſe and friable than the ſolid maſſes of the baſalts.

I have ſeen many quarries of this rock dug for the high roads, where the ſofter friable matter exceeded the hard maſſes in quantity, and in which encruſted ſtones of various ſizes and ſhapes appeared. Some of the largeſt maſſes in ſuch quarries have only a few coats of penetrable friable matter, ſurrounding a nucleus which varies in ſize, but which is uniformly hard throughout; and we ſhall find other yolks in the ſame quarry, imbedded in the ſofter matter, which, when broken, exhibit a neſt of ſtones including one another like the ſeveral coats of an onion.

Theſe cruſtated baſalts which envelope one another are a curious ſpecies of ſtone. The ſeveral coats of ſurrounding matter differ nothing in quality from the ſtones contained in them, and ſome of the inner cruſts are often very hard; but the nucleus within, though ſmall, is always the hardeſt.

The decompoſition by the weathering of the ſofter matter, found ſurrounding and inveloping the harder maſſes of ſtone in this and the ſecond ſpecies of baſaltine rocks, has produced a phænomenon frequently met with in Great Britain, eſpecially in Scotland, which greatly puzzles many. It is very common, in low grounds, and upon ſome moderate eminences, to ſee a prodigious multitude of ſtones of all ſhapes and ſizes, very hard, and pretty ſmooth on the outſide. Theſe ſtones are ſometimes ſo numerous and large, that it is often found impracticable to clear a field of them.

Where thoſe ſtones are a ſpecies of the baſalts, which they commonly are, and of the ſecond claſs or ſpecies deſcribed above, in that caſe, they always originate from the decompoſition of the more ſoft or friable parts of thoſe rocks, which moulder and fall away, and leave the harder ſtones detached and ſcattered about, and the decompoſed matter diſſolves by degrees, and becomes good corn mold.

The ſingular appearance and enormous ſize of many of theſe ſtones, makes many people and even men of letters imagine that ſtones grow like vegetables. But it is very evident to our ſenſes that ſtones cannot grow. They may, and many of them do, wear leſs and leſs, but they cannot grow larger, excepting in ſituations where there may be an accretion of particles of matter carried and depoſited by water, by which proceſs concretions and petrefactions are formed. Theſe ſtony productions are formed and increaſed in ſize by the continual accretion and addition of matter depoſited by water upon the outſide; but this differs widely from vegetation. Others imagine that theſe ſtones were rolled about, the aſperities and ſharp angles were by that means worn off, and that they were all at laſt depoſited as we ſee them by the waters of the univerſal deluge; and their having obtuſe ſides and angles, as if they had been rounded by being rolled in water, makes theſe gentlemen confident that they are right; and if we did not frequently find ſtones exactly of the ſame figure, ſize, and quality, in the rock, it would be very difficult to overthrow this hypotheſis. I have taken great pains to inveſtigate this point,—having frequently examined circumſtances, and never failed to diſcover the ſtratum of rock which theſe detached ſtones originally belonged to.

The beds or ſtrata of the ſeveral ſpecies of baſalts ſpread as wide and ſtretch as far as the other concomitant ſtrata in the neighbourhood where they are found; but they often lie very flat, or with a very moderate degree of declivity, and conſequently, when the ſofter and more friable matter, found in the interſtices of theſe rocks, which incloſes and binds the harder maſſes in their native beds, is decompoſed, the harder ſtones then muſt lie ſcattered wide upon the face of the ground. Rocks of this ſpecies and deſcription are ſo numerous in the Lothians, Fife, and other parts of North Britain, that it would be ſuperfluous to point out examples to a Scots gentleman.

4. Cruſtated baſalts, which is dry and friable throughout the whole maſs. This ſpecies of the baſalts is generally of a coarſe granulated ſtructure, and of all the various ſhades of the grey colours, from a ruſty black to a light coloured grey. We ſee this ſpecies of cruſtated baſalts developed when the maſſes are either broken or decompoſing. There are maſſes of this ſtone of all imaginable ſizes and ſhapes found in the rock, reſembling in figure and ſize the ſecond and third ſpecies of the baſalts, and they appear alike ſmooth on the outſide, with obtuſe angles,—in ſhort reſembling the other baſalts in every reſpect; but when they are expoſed to the external air and weather for any conſiderable time, the ſeveral incruſtations decay, decompoſe, and crumble down by degrees. When they quarry this ſpecies of baſalts for the roads, they are able to break and pound them ſmall with eaſe. Whereas, the harder ſpecies are ſo ſtrong and coheſive, that they are with the greateſt difficulty broken ſmall enough for the roads.

5. Compoſite baſalts, reſembling the three laſt ſpecies in figure, colour, and all external appearances, as it is found in the rock, and in looſe detached maſſes, but diſtinguiſhable from them only in the inner ſtructure and grain of the ſtone.

This ſpecies of the baſalts, which I call the compoſite, is not unlike ſome of the granites, as it is compoſed of much larger grains than the other ſpecies already deſcribed. Some of the larger grains in the compoſite baſalts are a fourth, and many of them more than an eighth of an inch over, and they appear with ſmooth flat ſurfaces, and of a tabulated texture, exactly reſembling the large quartzy grains ſo commonly found in the compoſition of moſt of the granites. The chief or only diſtinguiſhable difference between the grains in each of them is in colour. They are evidently large grains of quartz, &c. which exhibit flat ſhining ſurfaces in both. Theſe grains or fragments are commonly white, yellowiſh, red, or black in the compoſition of moſt of the granites; whereas, they are often ſeen of a pale blue, or a bluiſh grey colour, in the compoſite baſalts, and ſome of them approaching to white. Nevertheleſs, after all I can ſay to point out the difference, this ſpecies of baſalts has a very near reſemblance to ſome of the granites in the component parts, and in the internal texture of the ſtone: but with reſpect to the external figure of the maſſes, and the ſtructure of the rock, or the manner in which we find all theſe maſſes formed and lodged in the ſtratum, it differs nothing from the other ſpecies of baſalts.

6. The laſt ſpecies of this ſtone that I will take notice of is that which is indurated through the whole ſtratum, ſolid and uniform in all parts, and only exhibits ſuch cracks and fiſſures or cutters as we diſcover in all hard beds of ſtone. We meet with many beds of this ſpecies frequently in the coal fields, and are often obliged to ſink through them in our coal pits. The Saliſbury Craigs near Edinburgh might be ſingled out as a good example of this ſpecies of ſtone, were it not that part of the ſame ſtratum is formed into columns upon the ſouth ſide of Arthur's Seat; though I believe this is no good exception, as it evidently appears that the beds of baſalts which are formed into columns, glebes, &c. only aſſume thoſe figures where they are expoſed to the influence of the external air, or have but little cover of rock above them. When any of thoſe beds ſtrike deep under the cover of ſeveral other ſtrata, they are not found in columns, &c. Nothing but an uniform maſs then appears, although the ſame bed is regularly formed near the ſurface, which proves, that the columnar and

other baſalts are formed by ſhrinking and chapping.

I obſerved above, that the ſtrata of baſalts ſpread as wide and ſtretch as far in the longitudinal bearing, as the other different ſtrata that accompany them in the countries where they are found. I alſo obſerved, that the rocks of baſalts are generally found in very thick ſtrata, and that in places where no other rock is found above the baſalts, the ſtrata of it are often very unequal in thickneſs. But this in general is only in ſituations where no other rock is found above it; for when it fairly enters into the ſuperficies of the earth, ſo as to have other regular ſtrata above it, which is ſeen in a hundred places in the Lothians, Fife, and other parts of Scotland, it then appears pretty equal in thickneſs; as equal as moſt other beds of ſuch great thickneſs are; and yet it is remarkable, that although moſt of the ſtrata of baſalts are of great thickneſs, there are frequently thin ſtrata of various kinds found both above and below it. We have numerous examples of this in all the parts of Scotland where the baſalts is found, as for inſtance, there are thin and regular ſtrata ſeen and quarried both above and below the thick bed of that rock in the Saliſbury Craigs near Edinburgh.

In the Bathgate-hills, ſouth of Linlithgow, and in many other parts of Scotland, there are ſeveral ſtrata of baſalts; and alſo ſeveral ſtrata of coal, of limeſtone, freeſtone, and other concomitants of coal, blended promiſcuouſly, ſtratum ſuper ſtratum; and the baſalts is frequently found immediately above, and immediately below regular ſtrata of coal; of courſe, baſalts is not the lava of volcanoes. We can prove to ocular demonſtration, from the component parts, and from the ſituation, ſtretch and bearing of the ſtrata of baſalts, that they are real beds of ſtone, coeval with all the other ſtrata which accompany them, and are blended with them in the conſtructure of that part of the globe where they are found, as they dip and ſtretch as far every way as the other ſtrata found above and below them. So that if baſalts be a volcanic production, ſo muſt all other ſtrata be of neceſſity: but how volcanoes ſhould produce coal, and how that coal ſhould be regularly ſpread immediately above and below ſtrata of lava, is a little problematical; or rather, it is ſtrangely abſurd to imagine, that burning lava can come in contact with coal without deſtroying it.

Sixthly, The Breccia, or plum-pudding rock. This rock exhibits a very ſingular appearance in the ſuperficies of the globe. It is compoſed of bowlders and water-rounded ſtones of all qualities, and of all ſizes, from ſmall gravel, up to large bowlders, or rounded ſtones of ſeveral hundred pounds weight; the interſtices being filled up with gravel and ſand; and it frequently contains lime and iron.

When the breccia or pudding rock contains many large bullets of various colours and figures, it exhibits a formidable and groteſque appearance, diſcovering no marks of ſtratification, but appearing in one prodigious bed or maſs of bullets of unequal thickneſs, frequently ſwelling to the height and ſize of a conſiderable mountain; and this curious rock is often ſo ſtrongly cemented together, that the ſides of the hills of it frequently overhang in frightful precipices, which are not ſo apt to break off as many other ſtrong rocks in ſuch ſituations; and the reaſon of this ſtrong coheſion is, becauſe this rock, when compoſed chiefly of large bullets, exhibits few cutters and fiſſures, but is frequently found in one ſolid maſs of great extent and thickneſs.

But all the pudding rocks are not compoſed of ſuch large bullets. Some of theſe rocks are made up of ſmaller parts, approaching nearer the ſize of coarſe gravel. It appears evidently at firſt ſight, that all the parts of the breccia, whether coarſe or fine, have been rounded by agitation, and attrition in water, as the rocks differ nothing in appearance from the coarſer and finer gravel, found upon the beach of the ſea, excepting only, that the parts are ſtrongly cemented together in the rocks, and are looſe upon the ſhores of the ocean.

I have ſeen ſome of the breccia compoſed of finely rounded ſtones of various beautiful colours, about the ſize of plumbs and nuts; and all very hard and fine. If this ſtone was ſawed and poliſhed, it would appear as beautiful and elegant as any ſtone in Europe; as it would much reſemble Moſaick work in ſmall patterns, and receive a brilliant luſtre.

The breccia generally appears regularly ſtratified, or not, in proportion to the ſize of the component parts of the ſtone. Such rocks of this kind as are compoſed of round gravel and ſmall bullets, are generally as regularly ſtratified as common ſand-ſtone. Such again as hold bullets, like the firſt, and ſomething larger, are commonly diſpoſed into thick coarſe beds; and ſuch rocks of it as are compoſed of the larger bullets ſeldom ſhew any marks of ſtratification at all.

There are numerous leſſer hills and extenſive tracts of this rock in many parts of the Highlands, and north of Scotland; but as I ſhall have occaſion to review this rock afterwards, as well as the baſalts, and others, I will ſay no more about it here.

Seventhly, The regularly ſtratified quartzy mountain rock, of a white colour, a little tinged with a blue caſt, and often of a bluiſh grey colour.

In many parts of Britain this ſtone is ſeldom found. I have ſeen ſome little of it in the north, and it is very common in the Highlands of Scotland, where I have frequently ſeen it as regularly ſtratified as any of the ſand-ſtones, with other regular ſtrata of different qualities immediately above and below it; and ſometimes compoſing large and high mountains entirely of its own ſtrata.

This ſtone is exceedingly hard, dry, and brittle, full of cracks and ſharp angles; the different ſtrata ſometimes moderately ſolid, but often naturally broke into ſmall irregular maſſes, with angles as ſharp as broken glaſs, and of an uniformly fine granulated texture, reſembling the fineſt ſugar loaf.

There are large and high mountains of this ſtone in the ſhires of Roſs and Inverneſs, which in a clear day appear at a diſtance as white as ſnow, without any ſort of vegetation on them, except a little dry heath round the baſe of the hill.

Eighthly, I will take a ſhort view of the coal metals, which are a very numerous claſs of ſtrata;

but as I have examined them particularly in my firſt volume, I will only take a curſory view of them here, and I will chiefly take notice of the ſand-ſtones. There is a great variety of the ſand-ſtones, which are diſtinguiſhable by colour, texture, and degrees of hardneſs; and theſe are diſpoſed into thick, middling, and thin ſtrata. The ſpecies or variety I will take notice of at preſent, is the regular broad-bedded free-ſtone, of a laminated texture.

This ſtone commonly riſes in middling and thin ſtrata; and appears at the edges of a ſection, when broke or cut, to be formed of different thin lamina, or layers of ſand, equally laid on the whole breadth of the ſtone, and well cemented together.

I take no notice of the colour, nor of the ſeveral properties of the free-ſtones, having no view of claſſing ſtones. It is the formation into ſtrata, and the internal ſtructure of ſtones, with the various phenomena they exhibit in the ſtations they occupy in the ſuperficies of the globe, that anſwers my preſent views. I have ſeen a great deal of both red and white free-ſtone riſe in layers of five or ſix inches, and ſo upwards; and when the ſide of a grave-ſtone, or other ſlab, was poliſhed, regular ſtreaks, of a fifth or ſixth part of an inch, appeared the whole length of the ſtone, as if laid on by ſo many gentle waves of water, ſpreading each layer. Now, I wiſh particular notice to be taken of the inner grain and ſtructure of this ſtone, as well as of its regular ſtratification; and that the great regularity of the ſtratification, and the inner ſtructure of it, correſpond exactly; which I ſhall have further occaſion to remark in what I ſhall advance in my ſecond general head. The flaggy grey ſtrata, the ſtrata of ſlate in general, and many of the black and grey ſtrata of the coal metals, may alſo be ranked with this free-ſtone, for perfect and regular ſtratificacation; and likewiſe many other thin ſtrata of he coal metals.

I will alſo bring many of the thin argillaceous ſtrata into the ſame view. Many of the grey regularly ſtratified mountain limeſtones are alſo ſtreaked or ſtriped; and the ſtreaks in theſe appear more conſpicuous, when broken, than the ſtreaked free-ſtones; the colours of the parallel ſtreaks or ſtrips being brighter.. I obſerved before, that ſome of the hard regularly ſtratified mountain rocks are ſtreaked; and in all theſe three different ſtones, it is to be remarked, that the ſtreaks are all regularly and exactly parallel to the bed of the ſtone; which ſufficiently proves, that the ſame agent was employed in the formation of theſe, and of all the completely ſtratified metals; and that this agent acted with much regularity.

Ninthly, The grey flaggy ſtrata of Caithneſs, is another remarkable inſtance of regularity. The rocks of all the low country of Caithneſs, a ſquare of ten or fifteen miles, are bluiſh grey argillaceous ſtrata, with generally a ſmall quantity of lime in the compoſition of the ſtone, which is indurated to a greater degree than is common to ſuch thin ſtrata.

This ſtone is ſtrong and tough ; and all over this country it is diſpoſed in thin, broad-bedded, regular ſtrata. In ſeveral parts of the country, theſe flags are ſo thin and regular, and are raiſed ſo light and broad, that three or four of them cover the ſide of a ſmall houſe. Mr Murray of Caſtlehill has, perhaps, the beſt flags in all Europe, in a bay upon the ſouth ſide of the Pentland Frith. That gentleman raiſes them of any ſize and thickneſs he pleaſes ; and ſo truly flat and ſmooth, that he has only to ſquare the edges to make of them good loft floors, partitions, cheſts, mangers, roofs of houſes ; in ſhort, he does every thing with them.

The face of theſe flags are as ſmooth and true a plane, as if a perfect maſter had finiſhed them ; and indeed, they were finiſhed by a perfect maſter. The adorable Creator is the author of all this art and regularity : And the ſtrata in this bay is a beautiful inſtance of perfection in the works of nature, with reſpect to regular and perfect ſtratification.

There are ſeveral other rocks and ſpecies of ſtone in Great Britain beſides thoſe already enumerated and deſcribed, many of which I have ſeen and examined ; but theſe comprehend a ſufficient number and variety to anſwer my purpoſe in the ſequel of theſe inquiries. I have no view nor any inclination more minutely to arrange and claſſify ſtones. I am acquainted with gentlemen much more capable for ſuch an undertaking. My plan and genius leads me to examine the ſtrata which compoſe the ſuperficies of our globe upon a large ſcale. I delight to examine the rocky ſhores of the ocean,—to climb the lofty mountains, and take an extenſive view of the great operations of nature, and then to retire into the deep and ſolitary glens, where I ſee the anatomy of my ſubject,—where ſuch deep, various, and extenſive ſections of the ſtrata are found, as are very uſeful and very neceſſary in this inveſtigation.

I will now proceed to my ſecond propoſition, which was,

II. To give the natural hiſtory of the ſtratification of the ſuperficies of our globe,—of the bearing, ſlope, and continuity of the regular ſtrata,—

of the fiſſures, chaſms, ſlips, and other interruptions of that regularity; all of which concur in proving to a demonſtration, that water was the principal agent in the formation of that ſuperficies.

I have thus far prepared matters for entering upon an enquiry into the formation of the ſtrata; an enquiry arduous and difficult; and although it has occupied much of my attention more than forty years; and although, ſome time ago, I have endeavoured to remove many difficulties which obſtructed my progreſs, yet when I approach to a more minute inveſtigation, it fills my mind with awe and reverence. The origin, the hiſtory, and the delineation of this chaos, form ſo great an undertaking, that I dare hardly venture to explore thoſe dark and myſterious regions of nature.

All the phænomena of the ſtrata, and the partial hiſtory I have given of them, make it evident to me, that thoſe rocks and foſſils which we ſee laminated, ſtreaked, and ſpread out one above another, were formed by the waves of water put in motion by the tides and other natural cauſes: And that other rocks, ſuch as moſt of the granites and pudding ſtones, ſome of the baſalts and limeſtones, &c. have ſtriking appearances of the ſtony matter ſubſiding in deep water, and ſubſidence cannot properly take place in water greatly agitated or flowing with a ſtrong current.

It now begins to be acknowledged by almoſt all thoſe naturaliſts who enquire into the nature of the mineral kingdom, that they ſee the marks of water every where upon the ſuperficies of this globe. M. Buffon aſſerts, that every thing we ſee both upon and within the ſurface of the earth, carry ſelf-evident marks of the whole being formed by water, and he is evidently right in general in aſſerting, that water was the agent in this great work, but he is as certainly wrong in his account of the manner of performing it.

From all the phænomena which we can inveſtigate, both upon and within the ſuperficies of the globe, it appears, that all the materials which compoſe our rocks and ſtrata, muſt have been mixed with water in a fluid or chaotic ſtate, when the ſuperficies of the globe was formed, and all its curious rocks and ſtrata were organized.

At preſent I will take it for granted: I ſhall have occaſion to reſume the ſubject hereafter, and to make various enquiries relating to this chaotic ſtate of our globe.

It is natural to ſuppoſe, that the diurnal motion of the earth from ~~eaſt~~ west to ~~weſt~~ east upon its own axis, and the motion of the tides from eaſt to weſt, were not ſuſpended while this planet was in a chaotic ſtate before the preſent dry land appeared. Upon this ſuppoſition, it ſeems to me highly probable, that thoſe ſtrata which we ſee diſpoſed into regular order, were formed by the flow and waves of the tide ſpreading out the grains and particles of ſtony matter upon a large plane, and leaving them there. The phænomena of the ſtrata themſelves, and a ſlimy ſediment found betwixt the beds of many quarries, make this hypotheſis abundantly evident.

The moſt of the granites and breccia, ſome of the baſalts, limeſtones, and others not regularly ſtratified, I ſuppoſe were formed by the ſtony matter ſubſiding when the water was in ſome degree of reſt at the height of the tide, or from other cauſes of ſtagnation. Great quantities of matter lodged by a particular high tide in different places, might make many large temporary obſtructions by water containing great quantities of ſtony matter, which would ſubſide into a thick irregular ſtratum during the receſs of the tide; which obſtructions future high tides would break down and ſweep away.

I am convinced, by the phænomena of the ſtrata, that every ſtratum which we ſee regular was formed upon the then ſurface of the globe; that is, that the very part of the globe where a particular part of the ſtratum was made, began to be dry land before the tide brought with it the matter which produced that ſtratum; and ſo on, ſtratum ſuper ſtratum, tide after tide, until all the ſtrata were completed. And perhaps higher and lower, ſtronger and weaker tides, might have been the cauſe of thicker and thinner ſtrata, amongſt thoſe we call regular. We find the thick and thin ſtrata very unaccountably and capriciouſly mingled, unleſs we will allow ſuch a natural cauſe as the difference of tides.

I am alſo convinced, that when every individual ſtratum was made by the tide, that ſtratum was ſpread out by the water upon nearly an even level plane ſuperficies, extending the whole length and breadth of that ſtratum; and that the inequalities of declivity, the fractures and various irregularities we meet with, happened after each ſtratum, and in many caſes, after a great number of ſtrata were ſpread one above another upon a level ſurface.

To compare great things with ſmall, the ſtrata of ſand and mud lodged by great rivers in plains, by inundations from the mountains, are diſpoſed in layers very much reſembling our ſtrata of ſtone, &c. I have read an account of a deep well or pit dug in Holland, in which they found thicker and thinner ſtrata of clay, mud, and ſand alternately, to the depth, if I remember rightly, of about thirty or forty feet. There is no room to entertain a doubt, that theſe ſtrata of looſe matter were ſpread out there at different periods of time, by the inundations of the Rhine, &c. and thoſe ſeveral ſtrata dug through in Holland being

ing found in a looſe ſtate, without any appearance of cement or induration, is a proof of an obſervation I made in another place: viz. That ſuch adventitious ſtrata as are formed by accident upon the ſhores of the ocean, the banks of rivers, &c. at any time ſince the firſt formation of the ſuperficies of our earth, want the cementing quality which binds and connects our rocks with various degrees of coheſion.

Theſe adventitious ſtrata aſſiſt our ideas in forming a proper notion how the great work of the ſtratification of the ſuperficies of our globe was performed; and providentially theſe accidental ſtrata are all perfectly looſe and unconnected, without the leaſt approach towards any thing like cementing, induration, or coheſion.

I hope it will be acknowledged that this account of the formation of the ſtrata and rocks upon the ſuperficies of our globe, appears natural: At the ſame time, I am ſenſible it may be alledged, that it points at regularity, but regularity is no where found in continuation. I own, it may appear ſo at firſt ſight. However, I hope to convince every unprejudiced enquirer into theſe matters, that all the various declinations, breaches, and other interruptions to regularity we meet with in the ſtrata, are all, upon this hypotheſis, natural and neceſſary.

Let us ſuppoſe that the interior parts of the earth, below the viſible ſtrata, were formed by ſubſidence, and that from the agitation of the tides, this interior rock, as we may call it, would be full of greater and leſſer inequalities upon its ſuperficies, before the exterior rocks and ſtrata were formed. The great agitations of the waters or chaos, and the great run of thoſe high tides from eaſt to weſt, would undoubtedly carry and lodge the ſtony matter in great inequalities. Admitting the chaotic ſtate of the terraqueous globe, it is impoſſible to conceive that it could be otherwiſe; and the phenomena of the granite and pudding rocks greatly countenance and illuſtrate the poſition. Several mountains in Lochaber and in Appin, the mountains of Carngorm, amongſt many others in the Highlands of Scotland, and Cruffel in Galloway, ſhew us how the granite rocks are moſt commonly formed; and the pudding rocks upon both ſides of Lochneſs, in Roſsſhire, Sutherland, and many other places, I have ſeen exhibit much the ſame phenomena.

In the curſory view I took of the prevailing rocks of Scotland, it appeared, that there is, comparatively ſpeaking, but a very ſmall part of the granite rocks found in regular ſtrata. Sometimes we meet with this rock lying moderately flat and level, often diſpoſed into low inequalities; but the moſt common appearance of this rock is in hills and mountains, ſome of which are of great ſize and height; ſuch, for inſtance, are the mountains of Lochaber, Appin, and Carngorm, in the Highlands, and of Cruffel in Galloway. The moſt of theſe mountains, and many others of the ſame quality, which I have ſeen, are compoſed of one entire ſtone or maſs, from top to bottom, without the leaſt appearance of ſtrata, or any diviſions into different layers, or beds; and often with very few of the common fiſſures or cracks, which are ſo frequently found in other rocks.

I went up the bed of a large rivulet of four miles, in nearly a ſtraight line, upon the eaſt ſide of Bineves, in the Highlands, where the granite rock was waſhed clean the whole length of the rivulet, in which there was no appearance of any diviſion or bed, nor hardly a crack or cutter a quarter of an inch wide to be ſeen; but the whole rock was uniform and equal like the ſuperficies of a ſingle block of granite. Now it is impoſſible for us to meet with any thing in nature, that can give us a clearer idea of the ſtony matter ſubſiding in water with unequal ſuperficies, than theſe mountains of granite, and the leſſer hills of the breccia, or pudding rock, exhibit. That theſe mountains of granite, and other unſtratified rocks, have ſubſided with unequal ſuperficies, is evident to every obſerver; and in ſuch caſes, there is no diſputing againſt ſelf-evident facts, without being guilty of the greateſt abſurdity.

Various phenomena of the earth make it very evident, that the tides roſe to a prodigious height during the formation of the rocks and ſtrata, which compoſe the ſuperficies of the globe. The fluid chaotic ſtate of the terraqueous globe, was one reaſon of ſuch high tides at that period. The attraction of the ſun and moon would have a greater effect upon this planet, when the ſuperficies of it, at leaſt, were all in a fluid ſtate, than they could poſſibly have afterwards, when part of it only was fluid, and part ſolid. And the tides riſing ſo high in that ſtate of the earth, was the cauſe of our meeting with ſo many mountains of granite; ſome of which, though high, muſt have ſubſided altogether in one tide, which is evident, from their containing the ſame matter without any variation in quality or colour; and from their being one uniform maſs, without ſtrata, diviſion, or bed, from top to bottom, that can give us the leaſt indication of the matter being laid on, added, or ſubſiding at different times. But this is only to be underſtood as meaning ſuch parts of the mountains as are in our ſight. We can ſay little or nothing to ſuch parts as are not in our view.

As it is evidently matter of fact, that the mountains of granite are of the conſtruction which I have deſcribed, it muſt be acknowledged that the tides were high when thoſe mountains were formed. In this caſe the effect proves the cauſe, and the cauſe naturally accounts for the effect. Now, from theſe known facts which we can inveſtigate, we may form probable conjectures in caſes perfectly ſimilar. When we ſee inequalities upon the ſuperficies of the granite, and other rocks formed by ſubſidence, ſo conſiderable as to riſe to the height of great mountains, it is rational to conclude, that ſimilar inequalities would be occaſioned by the ſubſidence out of our ſight. During the firſt periods of the ſubſiding of ſtony matter in the waters, I think it a reaſonable ſuppoſition, that the interior parts of the globe would conſolidate before the ſuperficies. Beſides the preſſure of the ſuperincumbent chaotic matter, the attraction of the ſun and moon would be more powerful near the ſurface than further down, which would help to keep the more ſuperficial parts of the chaotic or earthly matter more looſe and mixed with water; and of courſe, the ſediment near the ſurface of the globe would be laſt in forming, and would be very humid and cavernous, as well as unequal and of a mountainous figure.

Having thus far prepared my way, I will now proceed to account for the inequalities and breaks of the ſtrata. When the then ſuperficies of the conſolidated parts of the globe began to riſe ſo high, or nearly ſo high, as the ſurface of the globe, ſo as the tides would begin to run and to form ſtrata, the firſt as well as the laſt of thoſe ſtrata would be ſpread out even and ſmooth upon a large ſuperficies. Now the firſt of theſe ſtrata would be ſpread out upon a very unequal and inſufficient ground, which was not only of a mountainous figure, but alſo containing a great quantity of water in the compoſition of the ſediment; and ſome of the caverns and hollows would be much more humid and ſlimy than others; and therefore, when the weight of the ſuper-incumbent ſtrata were laid by ſucceeding tides above this unequal, terraqueous baſis, and when the ſuperior waters began to leſſen in bulk and weight, by the ſeparation of the earthy and ſtony matter, and to retreat by degrees to the preſent bed of the ocean, and much dry land began to appear between tides, before the induration of the ſtrata had taken place, it became neceſſary that the water contained in the caverns and hollows, and in all the humid ſediment below the ſtrata, ſhould find its way out. The weight of the ſuperior ſtrata, as yet humid, ſoft, and flexible, would preſs hard upon the unequal ground below; and this preſſure of the ſuper-incumbent weight, would in time become ſo great, that the water below muſt force its way out, by breaking the ſuperior ſtrata in many places; and this forcing up of the interior water, drained out of the humid ſediment, is the origin and efficient cauſe of all the caverns, gaſhes, veins, and fiſſures we ſo often meet with, and behold with aſtoniſhment. A great quantity of water forcing its way out would make a large paſſage; and the violent manner by which this paſſage was made, would greatly diſturb and diſtort the ſtrata about the rupture. When the water had forced its way out with a violent eruption, the ſtrata being ſtill tender and humid, the aperture or cavern would, in whole or in part, be filled up by the falling in of the ſides or roof, which would diſturb regularity, and produce confuſion and diſorder a good way round. While the ſuperior ſtrata were borne up by the waters beneath, and continued whole and unbroken, they were all horizontal and level, or nearly ſo; but when the interior waters forced their way out, by burſting the ſtrata in many places, there would be made conſiderably unequal vacuities underneath the ſtrata; and of courſe, the ſtrata being not yet indurated, there would ſoon be great alterations upon the ſuperficies of the globe.

The yet humid and tender ſtrata would bend and break in many places, and ſink down into the vacuities beneath, which has cauſed the various declivities, ruptures, and other interruptions of the regularity of the ſtrata, which we every where behold. Where the interior vacuity was very deep, the parts of the ſtrata immediately above ſuch vacuity would be depreſſed ſo low, that the other parts which would reſt upon the ſide of an interior mountain, would be turned up nearly an edge. The ſtrata would dip and lean into theſe interior lakes, gulphs, and vacuities, with all the varieties and degrees of ſlope, of elevation, and depreſſion, which we every where meet with.

I ſaw at Springkell in Annandale, a deep limeſtone quarry, which exhibits the under or concave ſection of an arch. I had an end or profile view of this ſection, which was the beſt. The upmoſt ſtratum of this rock, next the graſs, was very ſhort, as that ſmall ſegment of the arch ſoon cropt out to the north, and to the ſouth. The ſecond ſtratum down from the graſs was conſiderably larger than the firſt. The third and fourth, and ſo on, continued to lengthen all the way down to the bottom of the quarry, as both ends or ſides of each ſtratum below came round and cropped out at the graſs above, as high as the upper ſtratum cropt out; ſo that all the lower ſtrata took an ample ſweep, and formed the concave ſemicircle of a magnificent arch.

This is a curious and a pleaſing phænomenon, which I know not how to account for, without admitting a vacuum underneath theſe ſtrata, into which the middle of them was depreſſed, and the ſides elevated while they were humid and pliant. It was this inequality of the ground below the ſtrata which was the cauſe of all the dykes, gaſhes, ſlips, and other inequalities and diſturbances in the coal metals. A vacuity of a certain extent and deepneſs would occaſion the ſtrata above to fall into juſt ſuch a degree of ſlope as the ſize and figure of the hollow below would admit of. Where the vacuum was deep, and the ſides of the ſubterranean mountains very ſteep, the ſtrata above would fall nearly on edge; and when ſhallow, they would only be depreſſed a little, which would give them an eaſy ſlope or declivity, and ſo on to all the intermediate degrees between the two extremes of the horizontal flatneſs and the vertical poſition of the ſtrata. Where the inequalities below were inconſiderable and near to one another, the ſuperior ſtrata would only bend downwards a little in ſeveral places contiguous without breaking, which would occaſion the inequalities of dip and the waving of the ſtrata, which we ſo often meet with, and which I have deſcribed in my obſervations on coal.

When a ſmall vacuity happened to be greater under one ſide than the other of a claſs of ſtrata, the weight of the ſtrata over ſuch vacuity preſſing down on one ſide, and the reſiſtance of the other ſide, which was ſupported below, would at laſt cauſe them to break acroſs, and the ſtrata upon one ſide of the breach would ſink down, and the edges of the ſeveral ſtrata would ſlide paſt each other at the fracture, ſo that the edges of thoſe which ſunk down would fall below the edges of thoſe they broke off from, on the ſide which ſtood firm, as many feet, or as many fathoms, as the vacuity below was deep or ſhallow, which was the cauſe of all the ſlips and hitches we ſo frequently meet with in coal-works and quarries, and we ſee in other places where the ſtrata appear.

I apprehend we may find another ſource of water to diſturb the regularity of the ſtrata, beſides that I have attempted to explain. The ſuperior ſtrata and rocks formed by the water and in the water, as the matter was laid on by the ſtreams, or lodged in ſediment at the height of the tides, would all at firſt be in a ſoft and humid ſtate, containing a conſiderable quantity of water, which would all by degrees ooze and drain out by the preſſure of the ſuperior upon the inferior ſtrata; and it is the property of water to ſink downwards, excepting ſuch as goes off by evaporation, when the particles are divided ſo ſmall as to be buoyant in the air. The water contained at firſt in the compoſition of the ſuperior ſtrata, while humid, when paſſing downwards by percollation, might for a while lodge betwixt ſome ſtrata, or in any vacuities it would find; but when the ſuperior preſſure became greater, by the addition and ſettling of the ſtrata, this water would alſo force its way out; and this, very probably, is the phyſical cauſe of many of the leſſer diſturbances and deviations from regularity, which we ſo often meet with in the coal metals and others. It is more than probable, that the water ſtrained out of the ſtrata might in ſome places produce even conſiderable diſturbances in forcing its way out.

It appears to me probable, that the water drained out of the ſtrata, and afterwards forced out from between them, might occaſion that ſort of diſturbance in the coal metals and others, which I have called a waving ſhake; and perhaps ſome of the leſſer twiſted ſhakes, which I have deſcribed elſewhere, might have the ſame original cauſe. The water between the ſtrata burſting a paſſage in a particular place, and in forcing its way out, breaking, twiſting, and diſtorting them, would produce great confuſion as far round as the influence of that current would reach. And I can eaſily conceive, that in many places, this water would be forced out with prodigious violence, by the great weight of the ſtrata above preſſing down upon it. In the formation of the ſtrata by water in motion, it is reaſonable to ſuppoſe, that ſome places would contain more water in the mud or newly formed ſtrata than others, and of courſe ſuch places would be more quaggy and weak than firmer places, which contained leſs water; a preſſure coming againſt ſuch a place would eaſily force a paſſage, and if ſuch weak place was of ſmall extent, the water might force its way upwards in almoſt a vertical direction, and ſo form a twiſted ſhake or a ſingle pipe vein in mineralogy.

We often meet with quaggy ſpots upon a ſmooth ſandy or ſlimy ſhore, ſo ſoft and wet, that you will plump in if not previouſly aware of them; and ſometimes the water will really burſt out of theſe quaggy places, although the reſt of the ſands near you ſhall be comparatively dry and firm.

I make no doubt, that one or other of theſe cauſes, which in many reſpects are the ſame, have produced all the phænomena we obſerve within the ſurface of the earth, wherever we meet with any thing that diſturbs or interrupts the uniform regularity of the ſtrata.

It is a common ſaying with many, (which I have often heard), when they meet with phænomena in the mineral kingdom, which they cannot comprehend, to call them "the ſport of nature," which is at beſt but a vague expreſſion, frequently made uſe of to conceal ignorance. I think it a much wiſer ſaying made uſe of by others, viz. "That nature does nothing in vain." I cannot help thinking that the laſt ſaying is remarkably applicable to the ſubject under contemplation. Granting the ſtrata to be formed by water, and I do not ſee how it can poſſibly be denied by any who take the trouble to examine circumſtances; we muſt then ſuppoſe a great quantity of water to be contained in the compoſition of each ſtratum at firſt, and that this water would filter and ſtrain out by degrees. It is as reaſonable to ſuppoſe, or in other words, it is neceſſary to allow this water a paſſage out ſomewhere. Go to a ſandy or ſlimy ſhore, towards the latter end of the ebb of a high ſtream tide, when the ſea retreats expeditiouſly, and there you will ſee how amazingly faſt the water is oozing out of the ſtratum of ſand which the waves formed, and the greater the ſlope is near the land, the quicker it drains out.

If the ſhore is very flat and the ſands exten five, it contains ſo much water that we dare not ride there. I have frequently ſeen ſands I durſt not walk upon, and men on foot and on horſeback have been known to ſink and periſh in them. The Solway Frith is infamous in this reſpect. Several barques ſtriking the ground, could never be got off the ſands again, but have been known to ſink over the maſt quite out of ſight in a few tides. This obſervation will help us to conceive what an amazing quantity of water there muſt have been in the compoſition of the ſtrata when firſt formed; and if we find it there, we muſt allow it a paſſage out ſomewhere: It would force its way out when a prodigious weight of ſtrata was laid on above, and the waters of the ocean had retreated far below the level of the dry land.

In a ſubject ſo great and extraordinary as this, we muſt either compare great things with ſmall, or elſe be left without any means of illuſtration, without any thing to aſſiſt our ideas; and we have need of all the aſſiſtance we can poſſibly find to aid us in this inveſtigation. Allow, then, that the newly formed ſtrata and unſtratified rocks did contain much water at firſt, this water muſt find or force a paſſage out; and I have no reaſon to doubt, that the breaking out of the waters from beneath, and from between the ſtrata, in greater or leſſer quantities, from all depths, and in all directions and degrees of force, was the phyſical, the neceſſary cauſe of all the great fiſſures, breaks, caverns, abruptions, twiſts, ſhakes, and other confuſion and irregularities we meet with in the ſtrata. I have ſeen examples which aſſiſted to confirm my perſuaſion, that the greater the incumbent weight above where water broke out from a great depth, the greater and wider confuſion it made.

I have ſeen great havock made in the ſtrata, in ſome places upon the ſhores of the ocean, under the ſides of large granite mountains. But I will not deſcend to particulars. It would prove too tedious; and every obſerving naturaliſt who will take the trouble, as I have done, of perambulating the mountains, valleys, and ſhores of the ocean, will find the truth of all my obſervations. Every curious perſon will find opportunities to examine particulars. I only wiſh in general, to be able to ſet the obſervations and reflections of the inquiſitive in a right train.

I have excepted the gaſhes, or the open fiſſures, which are wide above, and narrow below, from the interruptions of the regularity of the ſtrata and rocks, which were occaſioned by eruption of the inferior waters. At the ſame time, I am perfectly clear that the water contained in the ſediment at firſt was the mediate cauſe of theſe gaſhes. The drying of the ſuperficies of the ſtrata, by evaporation and percollation, was the immediate cauſe of them. When the great quantity of water contained in the maſs at firſt, drained, evaporated, or iſſued out, the ſuperior ſtrata muſt ſhrink every way in bulk; and beſides their diminiſhing in bulk from the loſs of ſo much water, the ſtrata, as I obſerved before, would fall, lean, and ſlide every way upon the water making its way from beneath them; and theſe effects jointly were the cauſe of the gaſhes, or wide chaps of the rocks and ſtrata: Or in other words, when the ſuperior ſtrata began to conſolidate, and the water was drained out, they would crack, and the inclination of the ſtrata, different ways, would increaſe the crack to a wide gaſh.

I think this part of my ſubject as clear, or as eaſy to be illuſtrated, even by ſmall examples, as any part of it I have treated. We ſee the earth chap in a dry ſummer. A brick-maker's clay ſpread out, and left too long in the ſun, without working, will ſoon crack all over. I have obſerved in divers places, that the ſuperior or upper ſtrata were chapped more than others below them. I mean, that a ſmall part of rock or ſtrata ſpread over a limited extent of country of a particular quality, above which there is no appearance of there ever having been any other ſtrata, and not much cover of any kind, exhibit the greateſt number of chaps. Such, for inſtance, is the limeſtone of the iſland of Iſla, and of Aſſint, which does not dip under the mountain rocks of the country. The limeſtone of Iſla is ſtratified, but there are no other ſtrata of a different kind above it. I have traverſed the whole of that piece of limeſtone, which is about ten miles over, and I never ſaw any ſo full of chaps and fiſſures as it is. This remarkable patch of limeſtone is altogether a mining field, which produces various ſpecies of lead ore, and ſome of them rich in ſilver. But the prevailing ſpecies in the iſland, is the common blue potter's ore, which is there remarkably clean when dreſſed, and free from pyrites and other heterogeneous mixtures, not eaſily ſeparated; and it yields an excellent produce in ſmelting. Some little copper is found in this field, in regular mineral veins, but lead generally prevails. I believe no country produces ſuch an amazing number of veins, in the ſame extent of ground, as appears in this limeſtone. The number ſurpaſſes imagination, and many of them are as promiſing regular good veins, as can be ſeen in any mining field; and they all diſcover leſs or more lead, accompanied with the beſt mineral ſoils, hard and ſoft. But notwithſtanding the ſurpriſing number of veins to be ſeen in this rock, I believe it would be difficult to determine which are moſt numerous, the mineral veins, or the hard whin dykes, which cut and interſect the lime in all poſſible directions. If the veins and dykes of this field were diſtinctly and properly delineated upon a large ſcale, by a good ſurveyor, it would be a valuable acquiſition for the curious and intelligent.

The whin-dykes there generally riſe above the ſurface of the lime, ſo as to be ſeen in ridges at a diſtance, interſecting one another. I have frequently ſtood upon an eminence, and viewed with aſtoniſhment the prodigious numbers of theſe ridges of ſtone which traverſe the lime-field, croſſing and interſecting one another in all directions. I account for the whin-ſtone, and other dykes in limeſtone, and the coal metals, &c. as originating from the ſame phyſical cauſes as the open gaſhes, viz. the draining of the humidity, and drying of the ſtrata.

The whin-dyke was a gaſh or chaſm at firſt, which was afterwards filled up by a high tide overflowing and pouring foreign matter into the gaſh; and the gaſh which continues open, or only contains ſand or clay, or other looſe matter, I ſuppoſe became gaſhes later, by the cracking of the ſurface of the rocks, after the high tides were ſo far retreated into their ordinary bed, that they would no more return to cover the earth.

We ſhould not look upon all this irregularity, all theſe caverns, fiſſures, breaks, and other interruptions of regularity, which I have been deſcribing, as if they were real blemiſhes in nature, of no further uſe than to anſwer the firſt purpoſe of giving vent to the ſuperfluous moiſture out of, and from under the ſuperior ſtrata. I conſider them all, or moſt of them, of great emolument to man.

The fractures in the ſuperior ſtrata, and the depreſſion and elevation of them into various degrees of ſlope, gives us an opportunity of viewing their edges at the many ſections of them we ſo often meet with, and of examining their crops or upper edges of the ſeveral ſtrata, which enables us to chuſe what is uſeful, and to diſcover and work coals, quarries, &c. The great ſubterraneous caverns and paſſages often give vent to noxious mineral vapours, and are frequently the channels of ſubterraneous rivers, many of which run into the ocean, and into great lakes.

Many of the gaſhes and larger fiſſures in the ſtrata, are the repoſitories where the mineral ores are treaſured up for our future uſe, and we know where to find it and draw it out, as the advanced ſtate of ſociety, of commerce, and the arts require it. What a bleſſing to Society in general are the metals! What a comfort to many cold countries is pit coal! how neceſſary to the arts, manufactures, and commerce! How could London, Edinburgh, Dublin, &c. ſubſiſt without it? Their conveniences and advantages, without theſe, would be greatly diminiſhed: It muſt be confeſſed, they could not be what they are without it.

Thoſe ſmaller cracks and fiſſures we every where meet with in great numbers, in the ſtrata commonly called cutters by our quarriers, which cutters divide our quarry ſtones into ſo many blocks or maſſes of various ſizes and figures, are conſidered by many as the effects of earthquakes and other violent concuſſions; but it is very evident to me, that they originate from another cauſe. Every perſon of obſervation and experience knows very well, that the nearer the ſurface, the cutters appear more numerous; and *vice verſa*, the deeper down there is the greater diſtance between them. I have ſeen many good quarries in which the ſtrata were divided at the ſurface by theſe cutters into angular maſſes too ſmall for uſe, which produced good blocks a little way down, and at a greater depth, there is often ſeveral yards ſquare between theſe natural cutters; ſo that the quarriers are obliged to cut out every block of ſtone they raiſe. If theſe were the effects of earthquakes, &c. they would be found as numerous below as above.

In fact, they are the effect of the ſlow and gradual yielding and falling of the layers of ſtone cloſer to one another, after the water was drained out, and induration was taking place; and we find them more numerous near the ſurface than farther down, becauſe the ſurface was not preſſed at firſt by the weight of any ſuper-incumbent matter; of courſe, it would contain more humidity, and retain it longer. When this was by degrees drained away, there would be the more room for the crops or ſuperficies of the ſtrata, to lean, ſlide, and fall cloſer together, and their yielding and preſſing together above, later than below, muſt neceſſarily occaſion more cracks or cutters in each ſtratum at the ſurface than farther down.

I have endeavoured to be as explicit as I poſſibly could, in explaining this great and difficult ſubject, and I have produced all the little examples which I thought moſt appoſite, by way of illuſtration, and I am ſenſible that all is little enough.

The ſubject is ſo great, comprehenſive, and difficult, ſo much above and beyond human capacity, that although I well underſtand what I would wiſh to explain, yet I do not find it an eaſy matter to communicate my ideas on the ſubject, ſo as to be perfectly underſtood by others. However, I hope, that the candid naturaliſt will underſtand me, and not condemn my labour; for although novices in this ſcience ſhould undervalue what I have advanced as wild and inconſiſtent, I flatter myſelf the experienced adept will acknowledge that my obſervations are the fruits of conſiderable application, much ſtudy, and extenſive experience. Nevertheleſs, ſeeing the ſubject is ſo intricate, I pretend not to unfold the whole arcana of nature, nor entirely to remove every difficulty and objection out of my way. There is one of conſiderable magnitude, which occurs at preſent, which I will attempt to remove.

The difficulty I mean is this: In my account of the ſtrata I call regular, which, from their ſtreaked and laminated textures, and their poſition one above another, &c. have unqueſtionable marks of being formed by the tides, or in other words, by the flow or current of water in motion. I ſaid that the firſt of theſe ſtrata was formed upon what began to be dry land, or where there was but little cover of water, or chaotic matter, at the ebb of tide; and if there were but two or three regular ſtrata in all, this matter would appear very plain and ſimple; but as we ſee in ſome high cliffs of the ſea, in deep rocky glens, among our higheſt mountains, and in ſinking deep coal pits, &c. many great and lofty ſections of the ſtrata, where we behold prodigious numbers of them in regular order, one above another, it may be difficult for many to conceive whence the grèat quantity of matter was to come from, which was requiſite for compoſing all the reſt, after the firſt two or three were done by the flowing of water? There are two or three circumſtances which contribute their joint aſſiſtance to enable me to remove this difficulty out of my way.

I ſuggeſted before, and I think it was a natural ſuppoſition, that the then ſurface, or what began to be the ſolid ſuperficies of the globe before the ſtrata were made, was ſoft and ſlimy, unequal and full of hollows, and mixed with a great quantity of water. Now, when a prodigious weight of ſtrata in a humid and flexible ſtate was ſpread out upon ſuch a ground, the water below would be forced out, and the ſuperficies of the globe would ſhrink down conſiderably. All the ſtrata, and eſpecially the mountains of ſediment, would grow thinner and be ſqueezed into leſs room as the humidity was drained out, and the prodigious weight of ſtrata above preſſed them together. This conſideration helps in part to remove the difficulty ſtarted. The globe ſhrinking by degrees into leſs diameter, as the weight of more ſtrata was added above, and the humidity drained out, the ſame height of tide would ſtill ſpread out more ſtrata. But this is not enough: it yet remains to be enquired, whence all the matter came which compoſed the ſubſequent ſtrata? I anſwer, that part, and only the ſmalleſt part, would be carried out by the interior waters, in their violent eruption when they burſt their confines. When theſe waters forced their way out with ſuch prodigious violence

lence as the incumbent weight of a great depth of ſtrata made neceſſary, when the ſuperior waters had retreated, no doubt, a conſiderable quantity of ſtony matter would be forced out with the water, which would contribute in part to form future ſtrata; but the far greater part of the matter which compoſe the regular ſtrata, came from the bed of the ocean, which purged itſelf, by the motion of the tides, of all the ſand and earthy matter which was before mixed in the waters, and laid it upon the ſolid and higher part of the globe in regular ſtrata; and the ocean does purge itſelf by the motion of the tides to this day. Though the larger rivers ſhould carry down ever ſo much ſand and ſlime into the ſea, it throws it all out again upon the land.

It is eaſy to be perceived, from what I have advanced upon this great ſubject, that I am firmly perſuaded the whole materials which compoſe the ſolid part of the ſuperficies of our globe, were once entirely mixed with the waters in a chaotic ſtate; and it appears from all the records of antiquity handed down to us, that this was a received opinion in the earlieſt ages all over the world. This was the chaos of the ancient poets and philoſophers.

No doubt this was handed down to them by early tradition ; and it is natural to ſuppoſe that ſome of the wiſeſt of them would examine nature, and finding the phenomena they beheld correſpond with tradition, would preſerve the memory of it long in the philoſophic parts of the heathen world. This early tradition might have been derived at firſt from ſome revelation ; but however they came by it, it appears to me very probable, that their firſt notion of the chaos then was much the ſame as mine is now, though it was in later times ſtrangely blended with fable and fiction, to countenance their various ſyſtems of idolatrous theology. What idea they had of it at laſt, is not eaſily conceived.

In the raw and humid ſtate of the ſuperficies of the globe at that time, it is to be ſuppoſed that ſtrong and powerful winds would frequently infeſt the lower regions of the atmoſphere, and theſe might have a powerful effect upon the ſtratification of the ſuperficies of the earth, and in producing ſeveral of the preſent phenomena we behold upon the face of the globe. If we will ſuppoſe that many of theſe ſtorms of wind were local, and only extended over a ſmall part of the globe at one time, it is rational to ſuppoſe that theſe local ſtorms of wind would have a mighty effect in driving or carrying the ſtony matter along with the tides, and lodging it in ſtrata in different places.

Perhaps this is the reaſon that we every where find ſtrata of the ſame quality in patches, which only ſtretch over a limited extent of ground, and then others of a different quality take place. But I will not enter into minute diſquiſitions of all circumſtances. I only mean to give the great outlines of this extraordinary work of nature. At the ſame time, I will juſt remark here, that in all my perambulations and reſearches, I have not been able to trace any particular claſs of ſtrata for any conſiderable length of ground, comparatively ſpeaking; for two or three hundred yards, and two or three hundred miles, are both of them inconſiderable, in compariſon of a zone of the earth. I once took it for granted, as I believe many others do, that every ſtratum was a zone, or at leaſt reached, I knew not how far; but I afterwards frequently examined circumſtances more accurately, in order to put this matter beyond a doubt; and both in Highlands and Lowlands, I found I was wrong; and now frequent obſervation and experience convince me that there is no ſuch thing as a very long ſtretch of the ſame claſs of ſtrata.

Obſervations upon the phenomena of the ſtrata which compoſe the ſuperficies of our globe, is a pleaſing and a fruitful ſubject of inveſtigation, which I have long examined, and could ſay a great deal more about it, were I not in danger of being impertinently tedious. However, before I diſmiſs it entirely, I will beg leave to make a few obſervations relating to the courſe or bearing of the ſtrata.

As I hold that the ſuperficies of this globe was formed by the waters put in motion by the tides, it is neceſſary, upon this hypotheſis, that the bearing of the ſtrata ſhould be due north and ſouth between the tropicks, and that they ſhould deviate a little from this line without the tropicks. On the north ſide, they ſhould lean or bend a little towards the north-eaſt, and upon the ſouth ſide, towards the ſouth-eaſt.

That this deviation or bending back of the line of direction, or bearing of the ſtrata, ſhould ſtill continue and increaſe, as it advances from the equator towards the poles, ſo as to form an eaſy ſweeping curved line acroſs the ſemi-diameter of the earth, from ſouth to north, &c. The attraction of the ſun and moon upon the ſuperficies of the globe, is greater between the tropicks than without them; of conſequence the tides muſt riſe to a greater height at the equator, than in the high latitudes without the tropicks; and as the attraction is greateſt between the tropicks, and the tides would riſe higheſt there, ſo would they run foremoſt at the equator, (to compare again great things with ſmall,) as we ſee the ſtream of a ſwift running river in a flood. The current in the middle of the river is always higheſt, and bears foremoſt. But the greater degree of attraction between the tropicks ariſing from the figure of the globe, and the ſituation of the torrid zone makes it neceſſary for the tides to riſe higher there, and to run with a forward head, or current; and this would eſpecially happen in the high tides in the chaotic ſtate of the earth; and if the ſtrata, in fact, appear in this ſuppoſed line of direction, it is a ſtrong collateral proof that my hypotheſis of the formation of the ſtrata by the tides, is true.

I have been told that the bearing of the ſtrata at the equator, is true north and ſouth, of the truth of which report I have not the leaſt doubt, as it appears neceſſary that it ſhould be ſo. In theſe northern latitudes of ours, the line of direction or bearing of the ſtrata, where they lie fair and regular, without being warped or thrown out of their due courſe by the influence of any particular cauſe, anſwers as nearly to my idea of the line of the tide, when the whole ſuperficies of the globe was in a fluid ſtate, as can be imagined; and the ſtrata in all this iſland, in high and low lands, in mountains and plains, bear to the ſame point in general. So far we can trace an exact correſpondence between the cauſe and the effect; and I cannot help thinking that they mutually prove and illuſtrate one another.

It has been erroneouſly aſſerted by many, that the ſtrata which compoſe the ſuperficies of our globe are diſpoſed according to the true order of gravitation, the heavieſt below, and the lighteſt above; but I have diſproved this hypotheſis in my obſervations on coal, where I have proved to a demonſtration, that the lighteſt and the heavieſt, with all the degrees and mediums, are blended promiſcuouſly in the coal field, without the leaſt regard to gravitation. There we find freeſtone, till, ironſtone, coal, till, freeſtone, limeſtone, coal, ironſtone, &c. &c. alternately one above another, without the leaſt regard to the laws of gravitation. In conſtant experience we find the order of the ſtrata run counter to it in the coal field, as we very commonly find ironſtone above coal, and every roof of coal whatever is much heavier than the coal itſelf. There are above thirty ſeams of coal in the lands of Gilmerton, with a prodigious number of all the various ſtrata commonly found in coal fields, interpoſed between them. There is not any mark of the order of gravitation in this field. But I need not inſiſt upon this point. It is ſufficiently clear; and in my account of the formation of the ſtrata, one above another, by the ſtream or flowing of the tides, there is no room left for the laws of gravitation to take place. If they had taken place, it is highly probable that we ſhould have greatly ſuffered by it—that iron and lead, &c. &c. had ſunk down abſolutely out of our reach.

But this affair is better ordered for our accommodation and convenience. An improved ſtate of ſociety cannot be ſupported without numbers variouſly employed, according to genius, inclination, ſkill, and bodily ſtrength. Induſtry, even when prompted by neceſſity, has a direct tendency for the good of the common wealth; and the greater the numbers well employed, it is the better for the whole community. Now, by viewing our ſubject in this light, it muſt be confeſſed that the ſuperficies of the globe being ſtratified, and the order in which theſe ſtrata are diſpoſed, is exceeding convenient for ſociety. For as the matter ſtands, we can make diſcoveries of, and work coal, ironſtone, lime, building-ſtones, mines, &c. In ſhort, every thing is ſo well appointed, and ſo properly diſpoſed for the good and convenience of man in a ſocial ſtate, that were he not mortal and vext with anxiety, and with unruly paſſions and appetites, and were not the ſpirit of man always diſſatisfied with preſent enjoyments, and ſtill aiming at ſomething more, this world would be a heaven upon earth. But the terreſtrial paradiſe is only ſuited to gratify the cravings of the bodily ſenſes. The immortal ſoul meets with nothing but diſappointment and diſguſt in this world; and therefore it inſtinctively puſhes forward its hopes and deſires to a ſtate and enjoyments more congenial to a ſpiritual nature.

In taking a ſhort review of what I have advanced about the formation of the ſtrata, I have the pleaſure to reflect that I have not the leaſt doubt of my being right in the main, though I may have erred in ſome little relative points; and though all the world ſhould refuſe its aſſent at preſent, it cannot hurt me in the end. I know upon what grounds I ſtand. All the phenomena of the ſuperficies of the globe above ground and below, are on my ſide; and in time theſe phenomena will be duly examined, and the reſult of the ſtricteſt ſcrutity which time can produce, muſt conclude in aſſent to the truth of what I have advanced.

It would be too tedious to enumerate every circumſtance I have examined, and which might be brought forward in proof of my opinion.

The regularity of the ſtrata is clearly on my ſide; and the irregularities, breaks, and interruptions we meet with, become neceſſary, upon the ſuppoſition of water being the mediate cauſe of this great effect. When the laminated and ſtreaked beds of ſtone are broke acroſs, the ſections of them preſent the effects of water in motion at firſt ſight. The ſeveral ſtrata, ſtreaks, and lamina, are ſpread out ſo regularly the whole length and breadth of the ſtone, that it is impoſſible to account for the effect from any other cauſe, than the motion or flowing of water ſpreading the matter upon a plane ſuperficies. And what may be called the leſſer ſtrata, or curious ſpecimens of ſtone, diſcover the ſame phenomena in miniature, as the great exhibit upon a larger ſcale.

When a ſection of ſome of them is poliſhed, it diſcovers regular ſtreaks or lamina for a little way, and then this regularity is broken, and the edges of the different ſtrips are ſlipt by one another, and yet we ſee them again in the other end of the ſtone, and this in miniature is as perfect a ſlip as we find in the coal metals. In ſhort, by a careful inſpection of the inner texture and ſections of curious ſtones, we ſee that the ſame work has gone on in miniature as we diſcover in the great ſtrata, and I believe it will be difficult to point out any material phænomena upon the face of the globe or within its ſurface, that, upon a careful and thorough examination, ſhall contradict what I have advanced. I do not think that any thing can be pointed out which is not perfectly reconcileable to my concluſions in general, though I may not have cloſed up every avenue againſt objections.

I have no doubt I could anſwer many objections, rectify many miſtakes, and clear up many difficulties and dark paſſages, if they were candidly pointed out to me. It can hardly be expected I ſhould be quite perfect in my firſt eſſay upon ſo great a ſubject, which is new; at leaſt as far as I know, my inveſtigations are new; at the ſame time, I am not the leſs confident that they are true.

I have carried my ſubject about in my mind more than thirty years, and met with many difficulties in the inveſtigation of ſome parts of it. Sometimes a ſingle difficulty has puzzled me for years, and when it was removed, a flood of light would ruſh in upon my mind, which would bring many diſcoveries along with it, beſides the clearing up of that one point; and then I would perceive the cauſe of my perplexity to be ſo ſimple, that I have many times wondered how it could be any difficulty at all. Many fatiguing journeys and perambulations I have made to examine how facts agreed with my reflections, and was often mortified with diſappointments when my reflections were in a wrong track. Notwithſtanding, I ſtill perſevered, and I always found that time, aſſiſted by obſervation and reflection, ſtill gave new acquiſitions of knowledge, and advances in knowledge and experience were always the means of removing difficulties, and of clearing up dark points.

Beſides the many voluntary perambulations and reſearches I have made, in order to bring difficult points to a ſatisfactory concluſion, my proper buſineſs was often very ſerviceable in furthering theſe enquiries. But though I carried my ſubject always in my mind, and embraced every opportunity of making obſervations, I never pretended to communicate my thoughts upon it, until I had removed every difficulty out of my way. The whole horizon is now clear before me, and the conviction of truth ſhines bright through every part of my ſubject.

Now, ſuch a fabric as this cannot be eaſily overthrown. It cannot be overthrown at all, although the loudeſt winds ſhould beat againſt it. If it meets with oppoſition, ſo much the better. Oppoſition will promote enquiry, and impartial enquiry will ultimately determine in its favours.

III. I ſhall now proceed to examine part of the modern ſyſtem of Monſ. Buffon, &c. to ſee how it correſponds with the real ſtructure of the ſuperficies of our globe.

In the diſcuſſion of this third general head of theſe enquiries, I will not take the trouble to turn over the modern ſyſtem or theories of the earth, in order to examine all their poſitions. Such an undertaking is too tedious for me, and is quite foreign from my plan, which is to communicate my own obſervations in travelling through the mineral kingdom; and therefore, I will content myſelf with examining ſome of their general doctrines, and comparing them with the ſtructure of the ſuperficies of our globe as explained above, which is known to every intelligent naturaliſt to be a true account of the matter.

"The earth (ſay the modern philoſophers) grows old, like a mother no longer able to bear; but new earth (ſay they) emerges out of the ocean, freſh and vigorous, fit to bear and nouriſh plants and animals for ſome time, and then it ſinks again."

Wild as this hypotheſis really is, it muſt be acknowledged, that when it is attended by all the arguments which they have adduced in ſupport of it, it appears at firſt ſight to have ſome ſhadow of truth on its ſide, but theſe ſhadows are illuſive, and conceal the real truth from our view. The mother of a ſeaſon grows old, it is true, and can bear no more; but the mother is renewed in the daughter, who bears in her turn, and ſo the race is continued. The earth receives annual ſupplies of ſoil equal to the waſte, from the decompoſition of the ſuperficies of the ſtrata, from the fall of the leaf, and the decay of all vegetables; the ſeaſons renew her youth, and prepare her to bear again with new vigour.

We know very well that Greece, Italy, and many other countries, which were once like the garden of God in fertility and beauty, are now comparatively barren and deſert; but it muſt be remembered, that thoſe fields were green and fertile in the flouriſhing ſtate of ſociety in thoſe countries; whereas now tyranny, horrid tyranny, reigns there.

Let us view this ſubject nearer home. How many extenſive tracks of land in this iſland lay waſte and deſert in the time of the Saxon Heptarchy, during the conteſts between the houſes of York and Lancaſter, and the longer conteſts and mutual invaſions of the Engliſh and Scots before the Union, which are now green and pleaſant fields, producing rich and yellow harveſts, and adorned with gay and beautiful villas, commodious farm-houſes, and populous towns. It is divine induſtry, attended and aſſiſted by divine philoſophy, when enjoying the bleſſings of peace and commerce, that enriches and adorns the face of the earth, that by the wiſe and liberal application of manure, and of alternate labour and reſt, give her all the vernal bloom of the gay and youthful virgin, and the more ripe and perfect charms of the nurſing mother; witneſs the wonderful revolution in the ſtate of agriculture in this iſland ſince the Union.

When Greece, Italy, &c. flouriſhed in verdure and fertility, induſtry and the arts, philoſophy and commerce went hand in hand, which encouraged population, and they were encouraged by internal peace and liberty. In a flouriſhing ſtate of ſociety, under a mild and peaceable government, and wholeſome police, induſtry and the arts reign triumphant, and every worthy member of the community pays them that true homage and reſpect which their real excellence deſerves. In ſuch a ſtate of ſociety, every perſon endeavours to make his fields as rich and fertile, and his habitation as commodious and pleaſant as poſſible; and the fruitful all-teeming earth anſwers his expectations, and rewards his labours, when liberally aſſiſted and prudently managed. But, on the contrary, when countries are deſolated, and continue under the baneful influence of tyranny and bad police, the beſt fields are ſoon choked in their own fertility, the rich champains become putrid marſhes, the green and pleaſant meadows are overflown and ſanded by inundations from the mountains, which before were kept within proper bounds. The higher grounds, and naturally poorer ſoils, return to their ancient ſtate for want of proper culture and manure, and all the face of nature aſſumes a melancholy aſpect of deſolation and barrenneſs. But let the ſcene be ſhifted again. Bring induſtry with all her friends about her upon the ſtage, and the enſuing acts will be more glorious and ſatisfactory: Happy revolutions ſhall ſucceed one another, and the whole conclude in fertility, plenty, beauty, and joy.

It is a known fact in agriculture, very well aſcertained by experience, that the ſoil, ſo far from diminiſhing and failing to bear, on the contrary, encreaſes under the hands of induſtry, both in bulk and fertility, when managed with liberality and ſkill. The greedy churl may reap often where he does not ſpread his manure, and if he does, his fields will puniſh him, by refuſing the ſucceeding crops they are not enabled to bear. But bad management is no rule by which to judge the fertility of the earth. She increaſes in richneſs under good management, and ſtill produces plentiful crops, and will continue to produce ſo long as ſhe is managed with induſtry, prudence, and juſtice.

Let us thoroughly conſider the force of theſe obſervations. They will bear examination by every teſt, and if that attention is paid to them which their importance deſerves, they will amount to a clear proof, that there is no occaſion for the change of the earth contended for. But that we may do all juſtice to Count Buffon, and the other favourites of the new philoſophy, let us, in the next place, examine the matter of fact, which requires our moſt ſerious attention, as there are many converts to the belief of this doctrine of the new philoſophy; and it muſt be acknowledged, that ſome of the phænomena of nature ſeem at firſt ſight to countenance and confirm their faith, but it is only at firſt ſight; when we come to look into facts, and to examine theſe phænomena to the bottom, we find, that the concluſions drawn from them are not only demonſtrably falſe, but that they are alſo big with the greateſt abſurdities, and infer conſequences which are abſolutely contrary to nature,—which are repugnant to her known laws, and contrary to experience. But let us examine circumſtances, and in ſo doing, it cannot be denied, that the ocean between the tropicks, and near them on both ſides, has a ſtrong current from eaſt to weſt; and it muſt be acknowledged, that this current has a conſiderable

able effect upon the eaſtern rocky ſhores in thoſe latitudes, and in higher latitudes further to the north and ſouth; wherever the tides ſet in ſtrongly towards the land, the ocean has in a degree the ſame effect upon the rocky ſhores of the continents and iſlands. In this inveſtigation of the ſubject, it is very evident, that theſe tides and currents have very powerful effects in wearing down and gaining upon the rocky ſhores of the continents and iſlands.

Where the rocks are either ſoft, or of a lax and open texture, their expoſure to the action of the air, and the powerful beating of the waves, waſhes them down by degrees into ſmall grains and particles.

Where they are more hard and firm, and of a ſtrong coheſive quality, the violent daſhing of the waves make way into ſome ſofter veins and fiſſures, which by ſlow degrees undermine and bring down the hardeſt rocks, and then the fragments are rolled and agitated in the waters, and by trituration and friction one againſt another, theſe fragments are alſo worn down at laſt into grains or ſands.

It is alſo very evident, that many inland rocks, by being expoſed to the action and changes of the atmoſphere, by degrees weather, decompoſe, and fall down into grains and ſands; others are undermined by the currents of rivers, rivulets, and lakes, which brings down fragments of them, the debris of which is worn down to ſand, by the motion of the rivers, &c. as effectually as upon the ſhores of the ocean. The ſides of mountains, and all the lower hills, are furrowed with innumerable rills of water, all of which have very ſtrong currents in rainy weather, and eſpecially after the melting of ſnows; and the inundation from the mountains and lowland floods, carry great quantities of ſand and mud in their mighty currents to the ocean.

Thus far circumſtances are in our ſight, and they may be eaſily and truly inveſtigated by every intelligent enquirer; and hitherto I agree with M. Buffon, but no farther: I can walk with him no longer, as the path he now chuſes leads to a land of darkneſs, which is full of " groſs chimeras." The concluſions he draws from theſe known and acknowledged premiſes are not true, and they infer many conſequences which our experience of the phænomena of nature aſſures us to be abſurd and falſe. He ſays, " that the
' mountains and all the higher grounds melt
' down entirely by degrees, and that the ſand
' and other ſpoils of the mountains and of the
' rocky ſhores are carried by the waters, and
' ſpread over all the bounds of the ocean, and
' that they ſubſide in the waters, and form the
' ſeveral

‘ ſeveral ſtrata in all parts of the bed of the ‘ ocean, as we behold them upon the ſuperficies ‘ of the earth: That the dry land which now ‘ appears was, in ſome ancient ages of the world, ‘ the bed of the ocean, and that what is now ‘ dry land will be under the ocean again in fu‘ture ages, and *vice verſa*, what is now ocean ‘ will be dry land: That not only the ſeveral ‘ ſtrata of different thickneſs and qualities, and ‘ all the other phænomena we diſcover in the ſu‘perficies of the earth, are formed under the wa‘ters by this ſuppoſed ſubſidence, but alſo that ‘ by the currents and other motions of the wa‘ters, mountains, and valleys, and all the phæ‘nomena we behold upon the ſuperficies of the ‘ globe, were formed under the waters of the ‘ ocean, and that the like are now forming for ‘ ſome future dry land.” I will go a little farther in my conceſſions, and own, that all this appears plauſible enough at firſt ſight, to ſuch as take for granted any hypotheſis that pleaſes them, without examining facts. But, however plauſible the above concluſions may appear at firſt ſight, when the circumſtances concerned are well examined, we find that they are not true. The ſand, &c. brought down from the mountains, and worn off the rocky ſhores, are not carried out and mixed with the waters through all parts of the ocean, in order to be formed into to ſtrata by ſubſidence; on the contrary, the ſea purges itſelf of the waſte of the rocky ſhores, and by that means the ſandy ſhores are formed; and the ſandy ſhores are the moſt effectual and moſt durable barriers againſt the ocean, to prevent its making any further incroachments upon the land. When once a ſandy ſhore is effectually interpoſed between the ocean and the rocks, the rocks are for ever after preſerved from any further injury or encroachment from the waves, as the ſands always increaſe in ſome ſlow degree, unleſs there is a ſtrong current in that place running parallel to the ſhore. Some of theſe currents, it is true, carry ſand, &c. frequently a great way; but then the matter ſo carried by currents is thrown out upon ſome near or diſtant ſhore, where it contributes to form ſandy, or ſlimy ground, and increaſes the dry land.

M. Buffon aſſerts that ſtreams of water always continue to carry down the diſſolved ſtrata, and to lodge it in the bottom of the ſea, until the land is worn down as low as the bed of the ocean, and that when matters are in this ſtate, the change is facilitated, the waters ſoon invade the dry land, and overflows it, and then new land emerges out of the ocean: And he further aſſerts, in ſupport of this hypotheſis, that all mountains are narrow ridges, or peeked at the top, which he ſays is a proof of their rapid advance towards this change.

I have already acknowledged that a conſiderable quantity of ſandy and ſlimy matter is carried down by the ſtreams from the mountains; notwithſtanding, if we examine the ſubject thoroughly, we ſhall ſoon diſcover that this is altogether but a trifling, unequal proceſs, no way proportioned to the ſubject, and that no ſuch tremendous cataſtrophe can be concluded from it. It is not true that the ſummits of all mountains are peeked or narrow ridges. The extenſive plains of New Granada in South America, are higher above the ſea than the ſummit of Teneriff. The country of Abyſſinia in the old continent, is near as high. Several other countries in many parts of the globe, eſpecially between the tropicks, are higher above the ſea than the ſummits of any of our neighbouring mountains; and can we call any of theſe narrow ridges? Some of theſe elevated countries are ſome thouſand miles of extent, and many of them ſtretch ſeveral hundred miles every way, which removes them far from the idea of narrow ridges; and theſe few inſtances are ſufficient to ſhew us that M. Buffon has not repreſented the matter fairly. The higheſt mountains in Scotland are ſo far from that deſcription, that they have generally very broad ſummits; and moreover, contrary to what M. Buffon and others aſſert as matter of fact, generally the higheſt parts of the higheſt mountains are the hardeſt.

Bineves in Lochaber is certainly the higheſt mountain in Britain. The ſummit of Bineves is broad, and the rocks upon the ſummit of it are ſo hard and tough, that I know not to what to compare them, excepting that wrought iron may come up to them in ſtrength and coheſion, but it is far ſhort of them in hardneſs. Now a hundred thouſand years can be ſuppoſed to have but a very ſmall and imperceptible effect upon this mountain; and many others are nearly of the ſame deſcription as this.

With reſpect to the ſmall quantity of matter that is carried down from the ſides of the mountains by ſtrong currents, it bears no proportion to the effects aſſigned. But the friends of this hypotheſis may aſk me what becomes of it then? If I will not allow that ſtrata were formed of it in the bed of the ocean, how can I diſpoſe of it? I anſwer, that it is all well and wiſely diſpoſed of for the benefit and advantage of the preſent earth, and the inhabitants of it. Part of it is lodged in lakes, and in deep unſeemly gulphs, in the courſe of the rivers, which are improved thereby into rich and pleaſant valleys and plains, and the reſidue is carried along by the floods, to the borders of the ocean, where it is very happily diſpoſed of to form new land, which in fact enlarges the bounds of our habitations, and in time becomes the moſt uſeful, the richeſt, and moſt convenient parts of the earth for ſociety and commerce. Great numbers of magnificent friths, extenſive bays, long inlets and arms of the ſea, have been filled up by the waſte of the mountains, which are now improved into rich and plentiful countries; and upon which are built many flouriſhing towns and cities, which enrich thoſe countries by the extenſive commerce carried on in them.

Theſe are your glorious fat valleys ſituate contiguous to the ſeas, and many of the rivers which formed theſe valleys are now confined in deep and narrow channels, fit for the reception and ſafe paſſage of tall and wealthy ſhips from all quarters of the globe; and upon their banks are ſeated ſome of the moſt flouriſhing commercial cities in the world, which are the ſcenes of art, of induſtry, plenty, and wealth, and where induſtry and commerce contribute to the wealth and convenience of the world.

Rivers carry down more or leſs of earthy matter in proportion to their magnitude, and the extent and figure of the ſuperficies their waters are collected off. Great rivers, which have their ſources in mountainous countries, carry down great quantities of matter to the valleys, and to the margin of the ſea; and eſpecially, if thoſe mountains abound in ſchiſtus, and other argillaceous ſtrata, which are apt to decompoſe and diſſolve into ſmall grains and particles; but then it muſt be conſidered, that this waſte of the mountains diminiſhes in proportion as the ſofter ſoils fail, and the harder come to be chiefly expoſed to the weather and the currents, and in proportion as the channels of the currents become more level and equal; ſo that in the courſe of time there ſhall very little come down with the waters. I have ſeen rivers run clear when greatly ſwelled with rain; and as the countries they riſe in and paſs through become more plain and level, they will at laſt ceaſe to carry down any more.

When great and weighty rivers, which are apt to be greatly ſwelled by inundations from the mountains, paſs through extenſive deſart woodland countries, they frequently tear up numberleſs trees by the roots, which are carried down by the waters, root and branch; and theſe, when they arrive at the flats, are often intangled in one another, and lodged heaps upon heaps in all directions acroſs the ſtream, which ſometimes choaks up the channel of the river, and turns it out of its former courſe to one or both ſides; and extenſive lakes and marſhes are frequently formed thereby; ſometimes in large plains which the rivers paſs through, but more frequently near the mouths of the rivers; and the lakes and marſhes are by degrees filled up with new matter, brought down by the rivers, which in time becomes rich and excellent ſoil. There is alſo a great quantity of ſand, mud, and rubbiſh carried by ſtrong rivers quite into the tide, and the tide throws it back again upon the land. A high tide, with a ſtrong wind from the ſea, and at the ſame time a great land flood, which frequently happens, often throws up great banks of ſand and rubbiſh upon the bars in the channels of the rivers, and on both ſides upon the ſhore, without the bars, which choaks them up, and forms large lakes and marſhes upon ground that was before poſſeſſed by the ſalt water; and theſe are likewiſe filled up in time by ſlime carried down the ſtreams, and ſo the dry land is enlarged, and ſtill continues to be enlarged, ſo long as a ſufficient quantity of matter is brought down by ſuch ſtreams from the higher grounds; but I deny that any part of it is carried out to remote parts of the ocean, and there lodged in ſediment. The ſtrong currents of ſome weighty rivers, it muſt be owned, carry ſand and ſlime a good way out from the ſhore; and this is not always, and in all places, wholly thrown back by the tides upon the ſame ſhore, but ſtrong winds, and eſpecially ſtrong currents running parallel to the ſhore, frequently carry ſome of it to a leſs and greater diſtance, but then it is aſſuredly thrown out by the tides upon ſome near or diſtant ſhore; for I conſtantly affirm that the ſea purges itſelf by the motion of the tides of every thing thrown or carried into it, excepting only in theſe two caſes:—1ſt, When maſſes of metal, or other ponderous bodies, are too heavy for the motion of the tides to move from the bottom:—And 2d, at a meeting of two or more tides, the ſands, &c. frequently accumulate in large banks, which ſometimes riſe ſo high as to form the baſis of iſlands. Belgia, the neighbourhood of Alexandria, in Egypt, and many other places, are clear proofs of the great and extenſive tracts of new land formed at the mouths of great rivers; and the Carſes of Gowrie and Stirling in Scotland, are ſmall, but valuable examples of it at home.

Geographers and obſerving travellers are full of their accounts of new land increaſing where great rivers diſembogue their currents. What encroachments muſt ſome of the great rivers of Africa and America make upon the borders of the ocean? Some of theſe have their ſources in a thouſand hills; and their deep and weighty currents flow ſeveral thouſand miles in length. But I need not multiply inſtances, either in proof or illuſtration of a fact ſo generally known and received on all hands. And this fact, ſo generally known and acknowledged, is a ſufficient proof, indeed an ocular demonſtration, that the matter brought down by rivers is not carried out through the bounds of the ocean, and lodged in ſtrata, in order to accompliſh a chimerical change.

We need not have recourſe to ſuch whimſies to account for the progreſſive operations of nature. They are more ſimple and rational, and of eaſy inveſtigation, if we will thoroughly examine all circumſtances. The Delta, and many other great plains formed, and now forming near the ſea, in many parts of the globe, makes this matter abundantly clear.

In the curſory ſurvey I have taken of the progreſſive operations and changes on the ſuperficies of the globe, we ſee nothing that either requires or indicates ſuch a cataſtrophe as the modern philoſophy contends for: On the contrary, the reſult of our enquiries makes it appear evident, that all the change which really happens, is by much for the better, and altogether in favours of the preſent earth we live in; which ſhews us that a wiſe and benevolent providence ſuperintends and diſpoſes the minuteſt operations of nature for good. The high and inacceſſible mountains, which are immerſed in the clouds, and in the cold and frozen regions of the atmoſphere, are penetrated and decompoſed by the changes of the air and weather, and waſhed down by the rains and melted ſnows; and the matter carried down by the floods is formed into new land, more level,

vel, uſeful, and commodious for man and beaſt. The coarſer grains, and hard, ſandy particles which ſwim deepeſt in the ſtreams, lay the foundation, and the more earthy ſlime is ſpread out to enrich and fatten the plains and valleys: and it is worthy to be remarked, that this new land is gradually made, as the progreſſive advances of ſociety has occaſion for it; and it is made in ſituations the moſt commodious for ſociety, viz. in the fat valleys and plains, upon the banks of great rivers, and near the ſea; in the midſt of plenty, and convenient for increaſed population; for improvement and increaſe of the arts, manufactures, commerce, and wealth. Many, I had almoſt ſaid moſt of the greateſt and wealthieſt commercial cities in the world are of this deſcription. They who cannot ſee, and will not acknowledge a wiſe and benevolent providence in this, are wilfully blind.

Let us now look a little into the conſequences of the ſuperficies of our globe being formed by ſubſidence in the bed of the ocean, as ſuppoſed by the new philoſophy; and whoever examines this hypotheſis with candour and impartiality, muſt confeſs that he can diſcover no traces of that uſeful diverſity, order, and regularity, which we every where find in and upon the ſuperficies of our real earth. If the rocks and ſtrata which compoſe the ſuperficies of the globe, were to be formed ed by ſuſidence in the bottom of the ocean, we ſhould have nothing but one uniform maſs of ſtony matter, compounded of grains and particles of all colours and qualities, without the leaſt diverſity or appearance of ſtratum, fiſſure, or breach of any kind whatſoever. It is neceſſary and agreeable to the nature of things, that in ſediment in water, all particles, of whatever qualities or colours, contained or ſuſpended in the water, muſt ſubſide next, and be blended through the whole maſs, in as abſolute a compound as wheat and rye flour in bread, when they are both ground together in the mill. There is not, I think, in the laws of nature, or in the compaſs of our reaſon or reflection, any thing that can be oppoſed to this, excepting gravitation; and if we will ſuppoſe that the laws of ſpecific gravity take place in this ſediment, where it is more likely to take place in perfection than upon any other hypotheſis I know; in that caſe we muſt ſuppoſe and expect, that all the metallic and moſt ponderous ſtony particles, would be ſunk loweſt down, and the lighteſt would always be uppermoſt; but we do not find it ſo in experience.

Nevertheleſs, to give the hypotheſis all fair play, let us ſuppoſe the matter to be ſpread out in the waters, and to ſubſide in a continued ſucceſſion of time; and this will only increaſe the confuſion.

The heavieſt particles have ſtill the tendency, and they have abundance of time allowed them to ſink down loweſt, and the next in weight would preſs hard after them; and others, in their own order of gravity, would follow cloſe upon the heels of the former, which in the end muſt produce a compound maſs, uniform and ſolid throughout, without the leaſt ſymptoms of, or inclination towards any of thoſe horizontal diviſions which we call ſtratification. Upon this hypotheſis, we ſhould have no diſtinct layers, or ſtrata; and therefore, of conſequence we ſhould have neither freeſtone, limeſtone, nor any other of the various ſtrata which are now ſo very convenient and beneficial to ſociety; but, inſtead of this uſeful variety, all the rock would be one uniform maſs throughout, compoſed of particles of all qualities. In this caſe, all our rock would reſemble the largeſt granite rocks. We need not pretend to ſay it might happen otherwiſe. The known and received laws of nature forbid it; and our granite rocks, which were in ſome reſpects a ſediment, are an ocular proof and demonſtration that all the rocks would be an uniform compound maſs, as I have repreſented.

Let any man examine a maſs of granite, and a hill of granite, which is only a large maſs without any bed or diviſion, either horizontal or perpendicular, in which maſs or hill, all the grains and particles which compoſe the granite are entirely commixed, without any order, through the whole body of a ſmall maſs, and likewiſe through the whole body of the mountain. I ſaw at Bineves, in the Highlands of Scotland, whole mountains of granite, of about twelve hundred yards of perpendicular height, which appears but as one uniform maſs of ſolid ſtone from top to bottom: and it is out of nature to ſuppoſe that rock formed by ſediment under the ocean, could be any thing elſe than an uniform maſs throughout, like the granite; and of conſequence, upon this hypotheſis, we could have no limeſtone, or freeſtone—no building ſtone of any kind—no ſlate, or marble, nor any other curious or valuable ſtone, for uſe or ornament—we could have no ſeams of coal, ſtrata of ironſtone, nor any other mine or foſſil we now enjoy; but inſtead of our uſeful and curious variety, we would have but one uniformly ſolid maſs of rock ſpread out over the whole face of the globe; and as we ſhould diſcover in it no ſort of diviſion, fiſſure, or opening of any kind, it would never come into our heads, to cut into ſuch an uniform and boundleſs maſs of ſtone, any more than it comes in our heads to dig into one of the northern mountains of ice. In fact, we ſhould, upon this hypotheſis, have nothing to dig with. Iron, &c. would be far out of our power, diſperſed in particles through the whole maſs.

Almighty, wiſe and benevolent Creator! how excellent are thy works!—how convenient for needy man!—how ſuitable to anſwer the deſigns of thy providence!—in wiſdom haſt thou made them all!

I have already made it evident, that upon this hypotheſis we could have no ſtrata or horizontal diviſions of any kind; and I am next to ſhew, that there could be no perpendicular fiſſures, nor chaſms in the ſuperficies of the globe; and of conſequence there could be no veins or beds of metal, or of metallic ore in any accumulated or collective body, as we now find it; but on the contrary, the metallic, and all other mineral particles muſt be diſperſed through the whole body and compoſition of the maſs of rock.

There could be no perpendicular fiſſures nor chaſms in the ſuperficies of the globe, becauſe ſubſidence in water, and which continues conſtantly under water untill the rock is conſolidated, has no opportunity nor poſſibility of any parts of the rock ſhrinking into leſs room by the humidity evaporating, or any way draining out of the maſs; but the particles of matter would gradually ſink downwards through the water, and inſinuate themſelves to fill up every cranny and pore in the ſuperficies of the ſubſiding maſs, and the water would be gradually excluded, and give place to the heavier particles of matter, and theſe more ponderous corpuſcles would preſs and adhere cloſer and cloſer, gradually and uniformly, by their own gravitating property, and by the equal uniform preſſure of the ſuperincumbent weight of the ſuperior waters, which at once preſs equally on all parts, and ſuſtain the whole maſs equally in all parts, ſo that no part can yield or give way on any hand, as there is no void place, or weak ſide to which it could yield; all the parts being equally full, and equally ſuſtained by the ſurrounding and ſuperincumbent waters. I have frequently ſeen extenſive pieces of ſediment, where water has been drained off by art or accident, and the whole maſs of ſuch ſediment was always found equally whole, ſmooth, and ſound in all parts, without the leaſt aperture, crack, or opening whatever, untill the water is drained off; and then when it is no longer preſſed and ſuſtained by the incumbent waters, it ſoon begins to yield on all hands, and to diſcover chaps and gaſhes, partly from the loſs of humidity, as the water drains out, and partly from the yielding of ſeveral parts of the maſs towards the lower and weaker ſides.

Many of our granite rocks which were formed by a haſty ſubſidence, exhibit exactly ſuch a maſs, and ſuch ſuperficies, as I ſuppoſe, rock formed by ſubſidence in the waters of the ocean, muſt neceſſarily have, with this only difference, that when the granite rocks were really formed by ſubſidence, they were ſoon laid dry by the retreating of the tides, and of conſequence, they would chap in ſome places, as the moiſture was ſtrained out. Accordingly we find there has been ſuch chaps and fiſſures in the granite rocks, ſome of which were afterwards filled with foreign heterogeneous ſtony matter of a different quality, brought by ſucceeding tides, and ſome of the fiſſures and chaſms were filled with mineral matter. Such are ſome of the mines of Cornwall, found in the muir-ſtone or grey granite; and ſuch are the lead mines of Strontian, in the Highlands of Scotland, &c.

This chapping of the ſurface of rock formed by ſubſidence, muſt neceſſarily take place, if it is either alternately wet and dry, by the falling away, and return of the tides, or when wholly laid dry by the water entirely retreating from it, while the ſtony matter retains any humidity before it is perfectly conſolidated. But this could not poſſibly be the caſe in M. Buffon's change of ſea into land, as the advances there would be ſo very ſlowly made, and would be accompliſhed in ſuch prodigious diſtant periods of time, that the rocks muſt be as effectually conſolidated before they were laid dry, as they would be to eternity; and therefore no room would be left for any change in the ſuperficies of the globe. Nothing in this caſe would be found, but one univerſal ſheet of rock covering the whole face of the globe, as ſolid, uniform and unbroken, as a ſheet of ice covers a pool of water, during the extremity of a hard froſt; nor would it ever be broken, as mankind would have no metal to make tools to pierce it with, the mineral particles being all either ~~mixed~~ throughout the general maſs, or ſubſided too far below the ſurface; nor could it ever ſuffer any violence from below by volcanoes or otherwiſe, there being no room left in the general ſediment for any veins or lodgments of the pyrites and other combuſtibles, nor any room for the admiſſion of air or water to diſturb or ferment them.

In ſhort, in this ſuppoſed ſediment, a compleat uniformity would abſolutely and univerſally exiſt over all parts of the globe; which, perhaps, might do well enough for a parcel of ſenſitive inhabitants, creatures who have no wants, but live on the herbs of the field, and lay them down and ſleep, without the neceſſity or inclination for any ſhelter. But for a mixed creature like man, who is expoſed to many wants and much wretchedneſs, which he is inclined to mitigate and provide for, by the induſtrious uſe of reaſon and the aids of ſociety, to ſuch a creature it would be but a very ſorry and unſuitable habitation.

What could we do in a world that produced neither coal nor iron, nor any other metal,—that produced no ſtone of any kind, either for houſes, harbours, or pavements, &c.? Our coal, ſtone and rion, with the other metals, are of ſuch vaſt uſe and importance to ſociety, that the bare naming of them in the forging, building, manufacturing, commercial iſland of Britain, is ſufficient to place them in an eminent point of view in the eſtimation of every intelligent perſon within the iſland; and moreover, in our earth, the very interruptions, breaks and fiſſures in the ſtrata, are ſo far from being blemiſhes and uſeleſs deviations from regularity, that they are of the utmoſt conſequence to ſociety, to the arts, and to commerce. They are the ſtore-houſes and repoſitories of mineral and metallic ores, without which, we could do nothing in our preſent ſtate, but eat berries and other ſpontaneous productions of nature, and then lie down under the next tree. Thank God we are better provided for:—We are richly provided with all that is neceſſary and convenient to relieve our wants and alleviate our miſeries; and therefore, let us reſt ſatisfied with our ample proviſion, and with the real œconomy of the indulgent providence of Almighty God, who wiſely directs all things for good, and we need not dream of any real changes in this world. We have ſeen that all the partial changes that happen are valuable improvements, and ſeaſonable ones too, both in time and place, as they give additional tracks of new land in maritime ſituations, as the advanced ſtate of ſociety and of commerce have a demand for it.

Upon reviewing theſe obſervations, it evidently appears, that there is no occaſion for a change of the ſuperficies of our earth, and that in reality no ſuch thing happens. If we manage what we have properly, it will not fail us,—it will encreaſe in richneſs and beauty under our hands, and that for ever, nor would another anſwer our purpoſe half ſo well. We have ſeen that the imaginary earth formed by our new philoſophers would not anſwer our purpoſes at all, and therefore we may ſafely draw this concluſion from our obſervations; namely, that blind chance brings about nothing worthy or uſeful for the emolument of man. The wiſdom of omniſcient providence is only adequate to furniſh a world for the accommodation of rational creatures. The wiſdom of man is unequal to the taſk of creating or improving worlds, though a thouſand Alphonſos ſhould find fault with this, or a thouſand Buffons contrive new ones.

IV. I now proceed to the fourth general head, under which I ſhall treat of the natural hiſtory of mountains; their ſtructure, internal and external phænomena, and the glens and excavations which belong to them.

The various phænomena of mountains have greatly puzzled the naturaliſts of all ages, and ſome of them have given to the world many abſurd and ridiculous concluſions, relating to the natural cauſes of theſe phænomena. I confeſs that the ſubject is too magnificent for my handling; however, as I have ſpent a conſiderable portion of my time among the higheſt mountains in this iſland, I will ſet down a number of facts, and make ſome obſervations and remarks relating to them, which have not been noticed by others.

Bineves in the Highlands of Scotland is unqueſtionably the higheſt mountain in Britain. When I was firſt upon the top of this mountain in a clear day, my mind was overwhelmed in amazement at the vaſtneſs and ſingularity of the proſpect around me. When I turned my eyes weſtward, perhaps no man who has not been there in a clear day, ever witneſſed a proſpect more full of real ſublimity and grandeur, yet highly pleaſing and agreeable. I could then ſee moſt of the Hebrides or weſtern iſlands of Scotland, which, with the head lands and promontories of the main, were ſo curiouſly interſperſed and blended with the waters, that it is paſt my deſcription.

To the north was a ſtupendous congregation of grey and naked rocks of great height and extent, with here and there a lake ſunk deep among the rocks. To the eaſt, was a range of great and lofty mountains, of a hundred and fifty miles, reaching all the way into Aberdeen-ſhire; and to the ſouth, were the magnificent mountains of Perth and Argyle ſhires, an extent of near a hundred miles every way, and the loftieſt in the iſland, excepting the one I ſtood upon. When I looked down upon the prodigious aſſemblage of mountains that were then jumbled together in the extenſive proſpect before me, I could not wonder that ſuch philoſophers as had neither ſkill nor opportunities to examine all the phænomena of the mountains, ſhould imagine that this globe is nothing but the mighty confuſion and broken ruins of a more fair and regular world.

At firſt ſight, ſuch vaſt, prodigious, ſeemingly broken, and unaccountably irregular accumulated confuſion, ſuch bare and rugged rocks and frightful precipices, I acknowledge, might ſuggeſt the idea of mighty fragments, to ſuch as are unacquainted with the phenomena of the ſtructure of thoſe mountains. I cannot blame them for entertaining ſuch an idea; but the preſumption of ſuch novices, in taking upon them to ſit down and write theories of the earth from ſuch curſory, imperfect views, and falſe conceptions of things, aſtoniſhes me.

Is learning and fine parts a ſufficient ſanction for impoſing falſehoods and abſurdities upon the world, or a ſufficient excuſe for attempting to explain what they do not underſtand? I hope to make it clear and evident, in the proſecution of my enquiries upon this ſubject, that every thing is as it ſhould be: That the exterior and interior phenomena of the mountains, are the real and neceſſary effects of natural ſecond cauſes, which cauſes I will attempt to inveſtigate and explain. In fact, I find at leaſt more extenſive marks of regularity in the ſtructure of theſe mountains than in any of the plains. But no comprehenſive view of this great ſubject will do. We muſt enter into a much more minute inveſtigation. Thoſe philoſophers who acquire diſtinguiſhed degrees of knowledge in any branch of natural hiſtory, accurately examine the ſmalleſt parts of their ſubject. I will endeavour to follow their example, and I flatter myſelf, that my hiſtory of the mountains will be ſatisfactory, and convincing to every unprejudiced naturaliſt.

In the proſecution of theſe enquiries, I will,

1. Examine the interior and exterior ſtructure of the mountains.

2. I will make ſome enquiries about the original formation of mountains. And

3. I will examine and explain the external phenomena of the mountains, and of their glens and excavations.

Agreeable to the method laid down, I am

1. To examine the interior and exterior ſtructure of the mountains.

I have before mentioned the hill of Bineves, and took notice, that the greateſt part of it and of the contiguous mountains round about it, are compoſed of fine granite or porphyry. Bineves is about a mile in perpendicular height, and is the king of a magnificent pile or cluſter of mountains in the country of Lochaber and ſhire of Inverneſs.

More than two thirds of the height of this mountain is compoſed of a moſt excellent and elegant red granite. What a treaſure would this have been in ancient Egypt, Babylon, or Rome! What a treaſure would it now be near London or Paris! Columns and obeliſks of any ſize and height might be cut out here, and the moderns might procure any ornaments they could fancy, as this exceeds every other ſtone for elegance, beauty, and duration.

I hinted before, that the granite or porphyry of this mountain is all as one maſs, without any appearance of ſtrata, diviſion, or fiſſure of any conſideration; and this whole maſs of granite is ſo regular and uniform throughout, that it exhibits not the leaſt mark or indication of ſtrata.

But notwithſtanding the uniformity of the baſis, and the great bulk of this mountain, the ſummit of it is, nevertheleſs, regularly ſtratified with a different ſtone, to about one fourth of the whole height: And it is worthy of remark, that contrary to the bold, but premature aſſertions of Count Buffon, the hardeſt rocks in this mountain are the higheſt. Granite is well known to be a hard ſtone. There is in a deep gulph at the bottom of a frightful precipice, about five hundred yards on the north-eaſt ſide of this mountain, a ſmooth and ſolid pavement of fine granite; and as a convincing proof of the ſuperior ſtrength and hardneſs of the ſtrata upon the ſummit of Bineves, there is below a fragment of ſeveral tons weight, which fell from the height of the precipice upon this ſolid pavement. It muſt have fallen about four hundred yards of perpendicular height; and as it lighted upon a hard pavement of rock, it is natural to ſuppoſe, that it would be daſhed to pieces by its own weight, but on the contrary, it is whole and entire.

This great fragment is of an angular figure, and it fell upon one of its corners, which is only a little marked, but it has bruiſed the face of the ſolid granite rock with a much more indelible ſcar.

The precipice I mentioned upon the north-eaſt ſide of Bineyes, exhibits a magnificent ſection of the inner ſtructure of that mountain, in which we diſtinctly ſee where the uniform maſs of granite ends, and the ſtratified rock begins to ride above it. We alſo ſee, that the ſtrata of different rocks dip towards the ſouth-eaſt with an eaſy declivity.

I have perambulated and carefully examined almoſt all the deep glens and hollows among theſe mountains, and there are no higher mountains, nor any hollows or gulphs ſo deep in any other part of Britain; and contrary to what is commonly imagined by the moſt of naturaliſts, who do not attend to all circumſtances relating to this ſubject, there is a ſurpriſing and uncommon degree of regularity among theſe mountains and glens.

This is the moſt rainy country in Britain, perhaps I may ſay in Europe. The mountains in general are very high in this country, and the glens and hollows between them are exceeding deep; of conſequence, the ſides of the mountains muſt be very ſteep, and of great length from top to bottom. The conſtant heavy rains have furrowed the ſides of the mountains with numberleſs gutters and gullies, all of which are waſhed clean by the heavy rains. The rivers and larger rivulets alſo run upon the bare rock, in all which I could diſtinctly examine the ſtructure of theſe mountains, and I declare that I never ſaw more regular ſtrata.

There are generally fewer breaches and interruptions of the ſtrata, and the declivity is more uniform and regular here than in the loweſt planes I have examined; and with reſpect to the continuation of the ſame claſs or aſſemblage of ſtrata in the line of bearing, I have as yet ſeen none ſo regular, or that ſtretched ſo far. The rocks appearing bare in many places, and the numberleſs rivers and rivulets which cut and traverſe theſe mountains in all directions, enabled me thoroughly to inveſtigate the poſition and bearing of the ſtrata. I have a hundred times traced a particular claſs or aſſemblage of ſtrata down the ſide of one hill in the rivulets, acroſs the river in the bottom, up the rivulets upon the other ſide of the hollow, and ſo on for miles, and found them commonly unbroken and regular.

I have, in that country, traced a particular claſs of ſtrata in that way, for near two hundred miles upon the bearing, which is nearly from north-eaſt to ſouth-weſt, and found both the bearing and declivity ſurpriſingly regular, even more ſo than ever I obſerved in any low country for half the extent. I will afterwards explain the reaſon of this regularity.

It is very worthy of remark, that the ſtrata of theſe lofty mountains, which I have obſerved to be ſo very regular, generally decline with an eaſy ſlope towards the ſouth-eaſt, and riſe towards the north-weſt, which I ſuppoſe was exactly the courſe or run of the high tides in the chaotic ſtate of the earth, which argument remains in part to be explained; and I have obſerved in very many places, that this, in general, is the point to which the ſtrata decline or dip, all over this iſland, which is a ſtrong proof of the truth of my Hiſtory of the Formation of the Strata, by the flow or ſtream of water.

There are a great variety of ſtrata, of different qualities, to be ſeen ſtretching and declining ſo regularly through theſe extenſive mountains: Such as ſeveral ſpecies of argillaceous ſtrata, of ſchiſtus, and of ſlate, ſome of which is exceeding fine; ſeveral ſpecies of limeſtone, of which there is a great quantity in this country, and ſome marble. The micaceous mountain rock, and the regularly ſtratified, hard, granulated, ſugar-loaf-ſtone, which was before called a white and light grey quartzy rock, from its being compoſed chiefly of minute quartzy grains. Extenſive rocks of mill-ſtone gritt, compoſed of hard, fine, ſharp, and pretty large grains of various colours. This rock is ſtrong, ſufficiently hard, the compoſition of ſharp grains being perfectly well cemented : It is very regularly ſtratified, and would riſe in beds of any thickneſs, and could be cut out of any ſize wanted. In ſhort, this rock only wants to be known, and a little better ſituated, to be a valuable acquiſition to ſociety for mill-ſtones. I ſaw this rock by the ſea-ſide at Lochbroom, upon the ſouth ſide of the Foreſt of Coygach : I alſo ſaw it upon the ſouth ſide of the Salt-Lake, or arm of the ſea which ſeparates Araſaig from Moydart. I examined the quality and texture of this ſtone at Coygach, and am perſuaded, remote as its ſituation is, that it would be worth the while for thoſe concerned to have a quarry opened, and ſome mill-ſtones cut out ; for as there are good harbours near the rock, and veſſels go there frequently to the herring fiſhing, they might be brought away to Glaſgow and other places, at an eaſy expence. Beſides theſe mentioned, there are other ſtratified rocks in theſe mountains, but this is a ſufficient ſpecimen of the regular ſtrata. There are alſo extenſive rocks of granite and breccia, which are not ſtratified, and the granite eſpecially is very extenſive in theſe mountains. Although the granites and breccia are not generally ſtratified in this part of the Highlands, they nevertheleſs preſerve the ſame courſe of bearing as the other ſtrata; I cannot ſay regularly, but rather irregularly. They are indeed as regular as any perfect ſtrata in the line to which they trend, but they are not regular in that line, as they are frequently thicker and thinner; ſometimes ſwelling to the magnitude and height of a mountain, and a mile or two forward, dwindling away to almoſt nothing; and further forward, ſwelling out again, in the ſame line, as I formerly obſerved of ſome of the mountain limeſtones; and there are other rocks and ſtrata among the mountains, which grow thicker and thinner in the line of bearing, and yet preſerve the line in general.

I think I have been ſufficiently explicit in explaining the origin or interior ſtructure of the mountains, and have made it abundantly evident, that, however rugged and unequal their appearance is without, all is fair and regular within, which at once knocks on the head the idea of ruins, and likewiſe of internal inflations, and other whimſical accounts of their formation.

There are as clear, diſtinct, and unqueſtionable marks of the mountains being formed and ſtratified by the motion of the tides, as of any of the valleys or coal countries; and if any one ſhall queſtion the truth of any thing I have advanced about the regularity of the mountain ſtrata, I am ready to convince him, by ſhewing all the local circumſtances in the country mentioned.

II. I ſhall now make ſome enquiries about the original formation of mountains.

As I have thoroughly meditated on my ſubject, I will attempt the hiſtory of the formation of the mountains, with all the plainneſs and perſpicuity I am capable of.

When I explained the hiſtory of the formation of the ſtrata in the ſuperficies of the globe, in my ſecond general head, it then appeared to me very evidently from all the phenomena of the ſtrata, and upon the ſuperficies of the globe, that there muſt have been monſtrous high tides at that period. I ſaw evident marks of ſuch tides, and alſo ſaw that it was impoſſible to explain the phenomena of nature without them; and therefore I was then obliged to ſuppoſe that the tides, from ſome cauſe or other, roſe far above the common height when the ſuperficies of the globe was formed.

Having ſince peruſed the Chapter on Tides, in Mr Ferguſſon's Aſtronomy, I there find, in the 297th paragraph, a clear and perfect illuſtration of this great point.

If Mr Ferguſſon were now alive, and was to write a paragraph, and draw a ſcheme on purpoſe to countenance my hiſtory of the formation of mountains, and of the ſuperficies of the globe in general, it would be impoſſible for him to add one word to his paragraph, or a ſtroke to his figure, that would be more to my purpoſe, than the words and figure I have juſt now alluded to. When I firſt read the paragraph, it looked ſo like being wrote for the purpoſe, that I was aſtoniſhed at it. I regret I never ſaw Mr Ferguſſon, nor had ever the leaſt correſpondence with him, nor did I ever ſee his book, till a few years ago, after writing what I have advanced about the formation of the ſtrata; and Mr Ferguſſon has been dead ſome years.

According to Mr Ferguſſon's ſcheme of the tides, (upon the ſuppoſition of the earth being a fluid globe,) it evidently appears that the tides actually did riſe ſeveral miles higher than the higheſt mountains in the world, when this globe was in a chaotic ſtate, before the buſineſs of forming the mountains and the ſtrata was completed.

When this globe was in a fluid chaotic ſtate, it appears to me more than probable, that the tides, in following the ſun and moon, would then be higheſt upon the two oppoſite parts of the globe, which are now the two continents—that the tide did not gradually and uniformly follow the moon weſtward, as the earth turned eaſtward upon its own axis in the diurnal motion, ſo as to be equally high upon every part of this globe, which was in every moment of time oppoſite to the moon, but that it advanced in great ſwells, and that each ſwell would, by its own weight and force, advance a little before the attracting force of the ſun and moon, which would bring the power of attraction to act the contrary way for a ſhort ſpace of time, which of conſequence would bring the tide to ſtand at a height upon two oppoſite parts of the globe for a ſhort ſpace of time: And that before the powers of attraction would begin again to bring the fluid to a motion weſtward, this globe would be advanced ſo far eaſt, that the powers of attraction would act ſo forcibly, as to cauſe another great ſwell of the tide, and ſo on. Now, if we will allow theſe oppoſite reſting places of the tides to be the two continents, the old and the new, we then have what we wanted, to enable us to account rationally for the phenomena of the ſuperficies of our globe. In this view of the ſubject, my former account of the ſea purging itſelf upon the land, by the motion and force of the tides, receives new light and ſtrength.

I cannot be brought to believe that the tides would move round gradually and ſmoothly; but that when any given parallel of the globe was ſo far advanced eaſtward during the height of the tide, the moon's attraction would fail to act where the tide was at the height, and would act in its greateſt force further weſt, which would cauſe the tide to ruſh from that height after the powers of attraction. Our trifling tides now do not move with ſuch ſmooth uniformity.

Let us ſtate the caſe, that the powerful attraction of the ſun and moon upon the fluid ſurface of the terraqueous globe, would raiſe the tides to the height ſuppoſed, and that the higheſt part of the higheſt tides really was upon thoſe two parts of the globe which are now the two continents, when the earth would be moved a conſiderable way eaſtward, during the height of theſe tides, and the moon's attraction acted much further weſt, theſe tides being forſaken by the powers which raiſed them to that height in thoſe places, would ſoon begin to yield, and by their own weight, aided by the powers of attraction, at their greateſt force they would ruſh forward with a force and motion ſo violent, as quite to overbalance the powers of attraction for ſome ſpace of time, as I hinted above; and perhaps the effects of that quick motion, or run of the tide, would not finally ceaſe or fail, untill it had gained the oppoſite ſide of the globe, a little paſt the main point of attraction, ſo that it would always, during that ſtate of the chaos, be high water upon the ſame two oppoſite quarters of the globe, once in every twelve hours, and a little more; and that it required the intermediate ſpace of time for the tide to run weſtward from the one continent to the other, and of conſequence, that the mean height of the tides would be upon thoſe two quarters of the globe which are now the two oceans. But I ſuppoſe that the tides would run through the ſpaces which are the two oceans, without any ſtop, real or partial, reſt at a height, and that they would only reſt at the height upon the two continents.

If it is allowed that the two continents were the quarters of the globe where it always was high water, at the end of a little more than every twelve hours, it of conſequence muſt be allowed that the tides ran without ſtopping through the two oceans in the intermediate ſpace of time.

When the tides in the chaotic ſtate of the earth once attained their higheſt pitch upon the two continents, as I obſerved before, they would ſtand ſtill without riſing or falling any thing material for ſome ſpace of time, and that always at high water; during which ſuſpenſion of the tides, the earthy matter would ſubſide plentifully upon thoſe two quarters of the globe; and if, as I have ſuppoſed, the tides continued to run all the while in the two oceans, during the high water in thoſe two quarters, the earthy matter being carried forward by the waters there with a rapid motion, could not ſubſide ſo plentifully in the oceans as upon the continents, where the waters came to a ſtand for ſome ſhort time at the height of each tide. Of conſequence, there would ſoon be a greater depth of water in the oceans for the powers of attraction to act upon, and theſe waters would be powerfully drawn over the continents by the force of theſe high tides; but the powers of attraction could not have the like effect upon the continents, to draw ſuch high tides into the oceans. In this view of the ſubject, it appears, that the earthy matter would ſubſide and be ſpread out by the motions of the tides, in ſuch quantities upon the two continents, that it would be ſo much exhauſted upon the land, that there would not be a ſufficiency left mixed with the waters to raiſe the bed of the ocean as high as the land, when the height and force of the tides began to abate, upon the emerging of the firm land, and contracting the fluid ſuperficies into leſs room.

If this hiſtory of the tides is allowed to be true, (and I do not ſee how it can be doubted), it throws much light upon my method of accounting for the phænomena of nature, and makes my hiſtory of the formation of the ſuperficies of the earth, and of the mountains, plain and clear to a demonſtration.

When the tides at firſt were higheſt in thoſe two quarters of the globe which are now the two continents, they would of courſe be always loweſt at the ſame time in the ocean; and as I obſerved, there would be no ſuſpenſion of the quick run of the tides in the ocean, except when it was low water there; conſequently, though ſtrata might be formed in the run of the tides, eſpecially when weakeſt, yet there could be no ſubſidence properly ſpeaking in the bed of the ocean, but only at the loweſt pitch of the ebb tide.

When the tides roſe very high, they of courſe fell proportionally low; and of conſequence, the ſame proceſs of ſtrata, &c. would be formed upon the ſolid ſuperficies of the globe for ſome depth under the ocean, as upon the dry land.

I ſhewed before, that the ſtrata and unſtratified rocks were formed by water, in different degrees of motion and reſt, or in other words, by the tides running, and at the height; and if the tides were always higheſt upon the two continents, it is eaſy to conceive how the land happens to be ſo much higher than the bed of the ocean. If the tides roſe in the chaotic ſtate of the earth to the height ſuppoſed by Mr Ferguſſon, it is eaſy to account for the great height of the higheſt mountains, as the tides then roſe much higher than the higheſt of them.

When this planet was in the chaotic ſtate ſuppoſed, the tides would riſe in a line from north to ſouth, or thereby, and theſe tides would be higheſt at the equatorial parts, and they would diminiſh in height gradually, as the line receded from the equator towards the poles. It is natural to ſuppoſe, that as the tides were higheſt in the equatorial parts of the globe, agreeable to Mr Ferguſſon's ſcheme, ſo would they run foremoſt there, and the line of the tide would recede a little backwards towards the eaſt, upon both ſides of the equator. This bending back of the line in the run of the tides, is a neceſſary conſequence of the height and ſituation of the equatorial parts, the powers of attraction being greateſt between the tropicks, and diminiſhing gradually towards the poles. Upon this ſuppoſition of the line of the tides, the courſe or bearing of the ſtrata in the equatorial parts of the globe ſhould be true north and ſouth; and as the ſtrata advance from the equator towards the poles, this line ſhould lean back towards the eaſt on both ſides. It is ſaid that they trend north and ſouth at the equator, and I am confident it muſt be ſo. In our latitudes, the line of bearing of the ſtrata is as true to this ſuppoſed line of the tide as can be imagined, which is nearly north-eaſt, or between that and N. N. E.

If the tides were then higheſt at the equatorial parts, the higheſt mountains ſhould be there alſo, and accordingly it is there we find them.

Our mountains in theſe northern regions are but diminutive, in compariſon to the Cordilleras in South America, and others between the tropicks; and if the greateſt, middling and loweſt height of all the principal mountains in the world, and the latitudes they are found in, were examined and compared with this ſcheme of the tides, we ſhall find them correſpond with it as near as could be deſired or expected. Indeed, we ſhall find a beautiful agreement and correſpondence in all the phænomena of nature, if we will but take the trouble to inveſtigate them a-right upon the principles of nature and truth.

In the chaotic ſtate of the earth, the deeper the fluid then was, the higher the tides would riſe, as the fluid maſs would be affected to the bottom by the principles of attraction, which is a ſufficient reaſon for the tides riſing ſo high in that ſtate of the globe, before the ſolid ſtrata upon the ſurface of it were formed, and the ſame holds ſtill in ſome degree. The tides now affect or move the ocean to its greateſt depths. This muſt happen in conſequence of the nature of attraction. If a fluid is moved at all by virtue of a diſtant body acting upon it by attraction, it muſt be moved to the bottom of that fluid; and therefore, our ocean is ſtill moved to the bottom by the tides, which is the reaſon of its purging itſelf on to the ſhores of all bodies thrown or carried into it, excepting maſſes of metal, or others too ponderous for the waters to lift or move from the bottom.

It is certain that all the phænomena of nature correſpond with, and mutually explain one another, if we can but inveſtigate them upon the true principles of nature. The flux of the tide towards the land is to this hour ſtronger and more rapid than the reflux, and this ſtronger and more powerful flux of the tides, ſtill continues to bring back to the ſhores ſuch matter as is carried into it by the rivers, &c.

As the tides muſt neceſſarily have been higheſt between the tropicks, it follows, of courſe, that the flux and reflux muſt alſo have run with greater violence there in the chaotic ſtate, than in the remote north and ſouth latitudes; and this more violent motion of the tides in the equatorial parts, would occaſion deeper terreſtrial and ſubmarine runs than in remoter climates; and this alſo is proved in fact, by the prodigious gulphs and immenſity of iſlands and rapid currents found between the tropicks, and near them on both ſides.

I hope I have now removed all difficulties out of the way, for accounting for the great height of many of our mountains, above the level of the ſea, and of the champain countries. The higheſt tides would firſt lodge the granite mountains as a foundation, and future tides not quite ſo high would form the ſtrata, which in ſome places we find riding above the higheſt granite rocks, and in others running parallel with them.

It is proper to obſerve here, that it appears to me more than probable, that many of the great ranges and cluſters of mountains were formed at firſt in a great plain above, and were afterwards cut through and furrowed, which I will explain in my next general head of this hiſtory of mountains. There is one very material circumſtance which I have frequently obſerved, which greatly ſtrengthens this opinion, and it is this. I hinted before, that I have traced the ſame range of ſtrata through ſeveral hollows, and over ſeveral mountains in the Highlands, in the courſe of which inveſtigation, I have frequently traced the ſame individual ſtratum, and a number of ſtrata from the deepeſt gulph or hollow, up to the ſummit of the mountains on both ſides of the hollow; and where a river cut right acroſs the ſtrata, I could ſee perhaps ſeveral hundreds of them aſcending gradually on both ſides, with an eaſy acclivity from the bottom quite up to the tops of the hills; and this plain phænomenon is found all over the Highlands, where the rocks are bare, or much cut and traverſed by rivulets.

The extenſive countries of Abyſſinia, Tartary, and New Granada, are all of them a great height above the level of the ſea, which appears to me as inſtances of ſuch high land, but not cut through to make mountains of.

Where we find an extenſive elevated plain in any part of the world, ſuch as New Grenada, and Abyſſinia, we may ſuppoſe that the tides fell ſo low, as not to overflow theſe plains ſoon after they were formed, by which means they have not been cut through and furrowed like the mountains, by forcible tides frequently running over them; whereas, on the contrary, where we ſee ranges of mountains dreadfully ploughed and trenched, with deep glens, and horrible gulphs and excavations, it is certain that weighty and powerful tides have repeatedly run over them for a conſiderable ſpace of time, and perhaps thoſe tides were raiſed to ſeven-fold rage and fury by mighty ſtorms, which tides would tear up the humid tender ſtrata; and by repeated mighty runs, would trench and wear down the gulphs and excavations of the mountains, before the induration of the ſtrata had ſufficiently taken place.

III. I will now proceed to examine and explain the external phenomena of the mountains, and of their glens and excavations.

I have clearly proved and illuſtrated one important point towards underſtanding and explaining ſuch phenomena of nature as appear upon the external ſurface of the globe, viz. that in the chaotic ſtate of the earth, the tides roſe to a ſurpriſing height, and if the tides roſe to that height, I need not ſuppoſe, (the propoſition has its foundation and proof in the nature of things,) that the earthy matter ſuſtained in, and agitated by ſuch amazing tides, would be lodged with unequal ſuperficies. This muſt neceſſarily happen. Such high tides muſt be greatly agitated from their own weight, and the violence of their motion, with ſometimes the addition of ſtrong winds, and conſequently ſtony matter carried by water in ſuch a degree of agitation, muſt be lodged in unequal cumulations.

I muſt not here be underſtood to mean that the mountains were lodged by the tides at firſt, as they now appear. I will preſently make it evident, that they owe many of their preſent phenomena to ſome future operations—I might call it future depredations. What I mean at preſent is this, that the tides, while in full height, in their motion from eaſt to weſt, lodged the ſtony matter upon what began to be the ſolid ſuperficies of the globe, in parcels or cumulations of different degrees of height and extent; but theſe higher cumulations, or parcels of land, would be of very different degrees of extent; ſome of them might not not be ſo much as four or five miles over any way; and ſome of them again would be much more than four or five hundred miles in ſome directions.

Theſe higher parts of the earth, when firſt formed, would be comparatively, but not perfectly, of equal height above, and they would be afterwards cut and furrowed, which will be explained.

That the ſuperficies of the globe would at firſt be formed with higher and lower places, or regions, is ſo evident, that I need not uſe more words about it; and it is evident that when the ſtrata and rocks were formed by ſubſidence and the motion of the tides, the ſuperficies of the earth would at firſt be ſoft and humid, and mixt with a great quantity of water, as I obſerved before. As the tides roſe at firſt much higher than the higheſt mountains, ſuch tides would advance with a ſtrength, weight and force, able to carry any quantity of ſtony matter with it; and when theſe tides had gained their higheſt pitch, and came to a partial ſtand at the height, it appears to me evident, that very great quantities have been lodged by ſubſidence in ſome places upon both continents, by a particular tide, even to the height of a conſiderable mountain.

There are mountains of granite in the Highlands of Scotland, and many other parts of the world, of great height and extent, in which there is no veſtige that ſhould indicate their having ſubſided at different times. The whole mountain, as I obſerved before, being one uniform maſs from top to bottom. It appears to me, that the work of forming rocks by ſubſidence, would be performed in a ſhort time, in the courſe of a very few tides; but on the contrary, that the ſtratification of the ſuperficies of the globe was a more leiſurely operation, which would require much longer time, and a great many ſucceeding tides. Moreover, the ſtony matter of which the granite and other ſubſided rocks are compoſed, is ſuch, that if ever the tide ceaſed in the leaſt from the full force and rapidity of its forward motion, we would expect that a great quantity of it ſhould ſubſide at once, as this rock is compoſed of large grains of a ponderous quality, ſome of which are ſo large, that they may be called fragments; and it is the property of ſuch ponderous grains and fragments, to ſubſide ſuddenly in water, at any degree of reſt.

When the tides roſe ſo very high, they would of conſequence fall proportionally very low, ſo that we may ſay that the foundations of the mountains would be ſeen; and when the waters, at the ebbing of every tide, began to fall away from the ſummits and ſides of the mountains and higher grounds, the moiſture which remained mixed with the newly ſubſided or ſtratified matter, would ooze, or ſtrain out, copiouſly at firſt, and this water filtering and ſtraining out of the humid ſuperficies, would ſoon collect into ſmall ſtreams, and theſe ſtreamlets would wear furrows in the yet ſoft and humid ſurface, eſpecially when aſſiſted by the weight and force of ſucceeding tides.

Many of theſe ſmall ſtreams would collect and form a rivulet, and many rivulets uniting their currents, would become a river. It is eaſy to conceive that all theſe ſtreams, eſpecially when collected into rivulets, would at firſt wear their ſeveral channels very faſt, and that much of the newly ſubſided matter would be carried down the ſeveral rivers, moſt of which would be lodged far down, and this would be removed by future tides, and diſpoſed of in ſtrata.

I can find nothing in nature ſufficiently ſuitable to illuſtrate this ſubject by; only I may obſerve in general, that any trifling ſubſidences which we have occaſion to ſee after great inundations in rivers, and after the tides in ſlimy creeks and bays of the ſea, generally fall into uneven ſuperficies, eſpecially when the waters are greatly agitated; and as the waters of the floods and of the tides fall away from ſuch ſediment, we always ſee it furrowed with gutters, by the ſtraining out of the water at firſt contained in it.

I have ſeen between ſome tides at the ſea ſide, deep gutters worn by the water filtering out of the mud and ſand, and the higher and larger the heaps were accumulated, always the deeper the gutters; and it is probable in the higheſt degree, on an accurate ſurvey, we ſhall find this obſervation hold good in the great as well as in little. The higher the mountains, generally, the deeper the glens and gullies in proportion.

I obſerved before, that the leſſer ſtreams and rivulets collecting together compoſed rivers. Theſe rivers would ſtill follow the great waters of the ocean in the retreat of the tides, and the weight and force of the rivers would ſoon wear channels deep enough to contain them, as they advanced after the great waters down the hills and through the planes. This appears to me the true origin of rivers, and the rains which fall upon the earth from time to time, and in greater quantity upon the higher than upon the lower grounds, ſtill repleniſhes their channels with never-failing ſupplies, and enables them chearily to continue their courſes, and communicate ſap and verdure to the vegetable tribes of the valleys, and plenty, pleaſure and refreſhment to the animal world, as they gently advance along in ſerpentine meanders through the ſweet and beauteous valleys and extenſive plains.

There are yet a great number of the external phænomena of the mountains which deſerve to be examined and explained. There are among ſeveral mountains, a great number of gulphs and chaſms, romantic precipices, gaſhes and irregularities in rocky countries, which are not now the beds of rivers, nor of rivulets, but are perfectly dry; and I have ſeen the oppoſite ſides of ſome hills reſembling one another ſo exactly, that they appeared as if they had been cleft aſunder by ſome convulſion which the earth might have ſuffered. I have met with ſome, who aſſert, not only that ſuch hills parted from thoſe upon the oppoſite ſide of them, but alſo, that ſeveral known iſlands were by ſome violent concuſſions thrown off from the oppoſite lands, and that the ſounds between them were made by theſe accidents.

With reſpect to ſuch gulphs and chaſms among rocks and mountains, as mentioned above, although they may now be dry, yet, nevertheleſs, water has been there. Some mighty current, ruſh, or eddy of the tide, before the ocean was ſettled in its preſent bed, undermined, ſcooped out, and formed theſe irregularities at firſt.

I have given ſome attention to the ſuppoſititious twin ſides of mountains, and in very many inſtances have diſproved the ſuppoſed breach and ſeparation, having ſeen the ſtrata waſhed clean by the rivulet which ran betwixt them, keeping a regular courſe down the ſide of one of the hills, acroſs the rivulet, and up the ſide of the other hill in the ſame longitudinal line of bearing, and the ſame ſlope or declivity perfectly whole and regular, without breach or fracture, which makes it clear to a demonſtration, that ſuch hills had ſuffered no ſuch ſeparation, change, or convulſion; but, on the contrary, that they ſtood as firm as ever where they were firſt formed, and that the gulph betwixt them muſt have been ſcooped out by ſome ſtrong current of water, before the induration of the ſtrata was compleated, and the tides fully ſubſided.

I have carefully examined many ſuch places, and every where found theſe obſervations hold good; and I am confident, that the notion of iſlands falling off from the main is an error, a haſty concluſion of the ſame kind, and that the ſame real and natural cauſe produced both theſe effects, viz. a ſtrong current or run of water, which cut a paſſage betwixt the iſland and the main, and betwixt the two correſpondent ſides of the mountains: and when we conſider, that the ſame arrangement of ſtrata ſtretch through both ſides of the mountain, and of the valley betwixt them, the phænomenon of the ſame ſtrata appearing on both ſides is plain and ſimple, and juſt as it ſhould be, allowing that water cut the hollow betwixt them; whereas, if the one had broke off from the other, the ſtrata could not have appeared ſo fair and regular in ſtretch and declivity upon both ſides; but the one ſide muſt have differed conſiderably from the other.

All the little examples of revolutions, or violent concuſſions, which we have occaſion to ſee, ſuch as earthquakes, the undermining of rivers, and of the ſea, &c. are ſo inconſiderable and trifling, that they give no ſanction to this raſh hypotheſis; and moreover, what falls off or is broken and diſturbed in theſe little inſtances, is always broke into confuſed fragments, or crumbled down to an entire rubbiſh.

It is reaſonable to ſuppoſe, that in the raw and humid ſtate of the earth, at firſt, a great quantity of a mixed vapour would aſcend by exhalation, which would diſturb the elements, and raiſe ſtrong and violent winds; theſe winds would ſuperadd an additional force to the high tides, even after the mountains were formed, which tides, at any rate, were exceeding ſtrong and violent when they roſe to ſuch an amazing height; and the forward courſe, and the eddies of theſe tides, would have a mighty effect upon the external ſurface of the earth, while they roſe ſo high as to flow, or ruſh over any part of it before the induration of the ſtrata was far advanced. I make no doubt, but all the great hollows, gulphs, precipices, and other irregularities we ſo frequently ſee upon the face of the earth, took their riſe from theſe cauſes. There is no room left to doubt of it, as all the external phenomena of the ſuperficies of the globe carry evident marks of water upon them. I have obſerved, I believe, more than once in the courſe of theſe enquiries, that there is an exact agreement and correſpondence in all the phenomena of nature, by which they are naturally explained and illuſtrated, if we had but the attention and ſkill to diſcover and make proper uſe of this connexion and agreement. I am going juſt now to produce a very remarkable inſtance in point, which will throw light upon the external phenomena of the mountains, and make the explanation of them more plain and perſpicuous.

Every obſerving perſon muſt have frequently ſeen in plains, at a little diſtance from large and high mountains, a prodigious quantity of coarſer and finer gravel, ſome of it containing large boulders, and water rounded bullets of all ſizes, mixt with ſmaller gravel, differing nothing in appearance from what we often ſee upon the ſea-beach; and ſome again compoſed chiefly of ſmaller gravel. This beachy gravel is often found ſpread out with a plane ſuperficies, and as often accumulated into long, round, oval, or ſemi-circular hillocks of leſſer or greater height and magnitude, and ſome of them ſo large, that they may be called little hills.

I will point out a few of the many places where I have ſeen this gravel in Scotland.

There is a great quantity of it in the neighbourhoods of Brora and Dornoch in Sutherland, as alſo, in the neighbourhood of Balnagown, and between Dingwall and Beuly, in Roſsſhire. All round Invernеſs, where there are pretty high hills of gravel,—all the way between Inverneſs and Nairn, and at Fort George.

There are large hills of gravel about Forres in Moray, in which there is a vaſt quantity of large bullets, and it continues to appear in hillocks, and ſpread out in planes all the way between Forres and Elgin, and all the way between Elgin and the river Spey at Fochabers.

There is a great quantity of it in the country of Monteith, and in a great many places, and in great quantities, in that long ſtretch through Perthſhire, Angusſhire, and the Mearns, all the way between Monteith and Stonehaven. There is alſo a conſiderable quantity of it between Moffat and Dumfries, and between Dumfries and Thornhill in Nithsdale. Theſe inſtances are a ſufficient ſpecimen. Every attentive traveller muſt recollect his having ſeen this bulky phenomenon in many other places, concerning which, I will make this remark: That in Britain, the greateſt quantities of this coarſe gravel are found a little to the eaſt of large and extenſive mountains; but of all the countries I have yet ſeen, the moſt amazing quantities of this gravel is found in the ſhires of Invernefs, Nairn, and Moray, which lie directly to the eaſtward of the great run, or gulph, which ſtretches or cuts through the mountains from the weſt to the eaſtern coaſt, by Fortwilliam and Invernefs.

It is very evident that this immenſity of rounded ſtones and gravel, is all of it the ſpoils of the mountains which was torn by the force of water out of the numberleſs glens and gulphs, and other excavations of the mountains, which I beheld with aſtoniſhment and pleaſure off the top of Bineves.

It muſt be owned that there is, at firſt ſight, an air of truth and propriety in what I advance concerning the ſource and origin of the plains and hills of gravel which we ſee ſo frequently. It appears to me plain and evident, that the ſtony fragments torn by the violence of water off the ſuperficies of the rocks in theſe mountains, was afterwards carried through the hills, and after being toſſed and rolled by the violent force of the water in ſo long a courſe, until it was rounded and worn by water, like what we ſee upon the ſea-beach, it was at laſt lodged by the water in the countries where we now ſee it; and the greatneſs of the quantities found in thoſe countries ſufficiently proves the ſource from whence it came. We may, upon the ſame principle, account for moſt of the phenomena we meet with upon the face of the globe. If we have recourſe to water, the ſolution of the phenomena will be natural and eaſy; but on the contrary, if we refuſe its agency, we ſhall be left in the dark, to doubt and conjecture without end.

How delightful is the path of truth, when we have once found it!—how clear and ſatisfactory are the plain and unbiaſſed dictates of nature! When I was upon the head of Bineves, and ſeveral other mountains in that country, I was as much amazed at the profundity of the hollows, as at the height and multitudes of the hills; and if we conſider the prodigious numbers of the greater and leſſer glens that are made, the lakes and gulphs that are ſcooped out, and the runs that are cut through theſe mountains, from ſea to ſea, we are obliged to ſuppoſe that the quantities torn off the ſuperficies of the ſtrata, was even ſtill more than the beds and hills of gravel can account for. Great and extenſive as thoſe are, they do not correſpond with the excavations of the mountains; and we are not left to look for it all in the gravel beds. We ſee a much larger depoſition of it than the accumulated gravel, where it is much better diſpoſed of.

The beds and hillocks of gravel are a great nuiſance. Nothing but dry ſterility reigns where they are; and had all the ſpoils of the mountains been ſpread upon the plains, the plains and valleys would not, as now, have been the ſcenes of the wealth and pleaſure of man—every low field and valley of them had been all covered with bullets and gravel. But happily for us, the greateſt part of this nuiſance is diſpoſed of in rock—ſtrata I cannot call it, as the coarſe ſort, which differs nothing in appearance from the hills of gravel, is not ſtratified. The only material difference between the one and the other, I mean between the coarſer breccia or pudding rocks, and the coarſer gravel hills, is, that the rock is ſtowed out of the way, bears its proportion of the ſolid bulk of the globe, and is cemented and indurated to a high degree; whereas the gravel beds and banks are a great nuiſance, and are generally quite looſe, without cement or connection. I ſay generally—for I have ſeen ſome gravel plains half cemented, and very hard to dig for the high roads.

In order to give a further idea of the proportion between the matter ſcooped out of theſe mountains, and the repoſitories where it is lodged, I will juſt point out a few of the places where I remember to have ſeen moſt of this rock in Scotland.

In this curſory review I will begin with the north.

There are extenſive rocks and high cliffs of the breccia or pudding-ſtone upon the ſouth ſhore at the weſt end of the Pentland Frith, to the weſtward of Thurſo in Caithneſs, which ſtretch quite acroſs the county of Caithneſs into Sutherland; and in Sutherland as well as Caithneſs, this rock is of a rough contexture, and appears in pretty high hills, deep glens, overhanging rocks, and frightful precipices, to the weſt of Brora, Dunrobin, and Dornoch, which gives it a groteſque and formidable appearance in that country.

This range of breccia ſtretches alſo quite through Sutherland, and likewiſe through Roſs-ſhire, the weſt ſide of Ferndonald, and Dingwall, where it exhibits the very ſame phenomena as in Sutherland and Caithneſs.

It is worthy of remark, for the information of the curious, that there are remains of ſeveral ancient vitrified forts upon ſeveral eminences in the line of this range of breccia, which I have ſeen in Sutherland, Roſs, and Inverneſs-ſhires, ſuch as one at Creich, name unknown, Knockferril, and Craigphadrick.

The ruins of two of theſe vitrified forts, viz. Craigphadrick and Knockferril, were deſcribed a few years ago in a pamphlet which was publiſhed, entitled " Account of remarkable ruins of ancient " vitrified forts, lately diſcovered in the Highlands " and north of Scotland." Theſe ſingular ruins are to be ſeen in a great many places; but it is remarkable, that they are only to be ſeen upon rocks and eminences of the breccia.

This formidable range of the pudding rocks ſtill continue the longitudinal line of bearing, which is nearly from north-eaſt to ſouth-weſt, quite through the highland countries of Inverneſs and Perth-ſhires. It forms conſiderable hills, and very high and rugged rocks upon both ſides of that beautiful piece of freſh water, Lochneſs. Much of the ſtone here, as well as in other places in this range of rocks, is compoſed of large bullets; the rock is very hard and ſtrong, and it hangs in frightful precipices upon both ſides of the lake, through which rock General Wade cut a fine military road upon the ſouth ſide of the lake, at a great expence of time, labour, and gun-powder.

I have ſeen theſe rocks ſtretching through the mountains of Stratherig into Badenoch, where it forms a remarkable rock and precipice called Craigdow, or the Black Rock.

I have ſeen this identical range of rocks again, further towards the ſouth-weſt, in ſeveral places to the ſouth of the Black Mount, and in the country of Glenorchy in Argylſhire: I ſuppoſe that the longitudinal line of this rock, ſo far as I have pointed it out, is little leſs than two hundred miles, and in ſome places this rock will ſpread eight or ten miles in what may be called the latitudinal line acroſs the bearing of the rocks, which evidently points it out to be a very conſiderable thing.

The next moſt magnificent range of the breccia which I have yet ſeen, is ſituated above ſixty miles further eaſt than the one above-mentioned. The one I am now going to point out emerges out of the ſea at Troop-head, upon the ſouth ſide of the Moray Frith, and ſtretches through Aberdeen-ſhire into the Mearns, and through the whole length of the Mearns, Angus and Perth-ſhires, keeping principally the northweſt ſide of the country of Strathmore, immediately under the ſouth-eaſt ſide of the Grampian mountains, though ſometimes it ſtrides acroſs the beautiful valley of Strathmore, and is found upon the ſouth ſide of it, as at Kinfauns below Perth, &c.

There have been ſeveral vitrified forts upon this range of breccia alſo, ſome of which are pointed out and deſcribed in the pamphlet mentioned above.

This remarkable rock ſtretches through Perth-ſhire into Stirling-ſhire, through the country of Monteith into Dunbarton-ſhire. It croſſes the river Clyde near Dunbarton, and reaches into the weſt ſide of Ayr-ſhire, where it enters the Frith of Clyde, and I can trace it no further. This range of the breccia exhibits in many places the ſame interior and exterior phænomena as the firſt deſcribed; and in other places in this long ſtretch, it is found of a finer contexture, and compoſed of ſmaller gravel, where we ſee it regularly ſtratified. I am not ſure that this courſe of the breccia is not ſtill of greater length and breadth than the firſt. There are other arrangements of the breccia in many parts of the Highlands and north; but none ſo conſiderable and extenſive as the two I have pointed out. There is alſo a conſiderable quantity of this rock found in the countries of Annandale and Nithſdale, particularly in the neighbourhood of Dumfries, between Dumfries and Moffat, and between Dumfries and Thornhill, &c.

The Pudding Rocks found in the Highlands and north of Scotland are ſo very extenſive, that when joined by the hillocks and beds of looſe bullets and gravel in thoſe countries, I doubt if the excavations of the Highland mountains to the weſtward would be ſufficient to ſupply the prodigious quantity requiſite for compoſing theſe rocks and accumulations of gravel. I am confident, that a conſiderable part of the compoſition was carried through the Highlands from the weſtern iſles.

When I was upon the ſummit of Bineves, it appeared to me evident, that the Hebrides or weſtern iſles of Scotland, had been at firſt formed all in one continued ſtretch of land with the contiguous Highlands, and with one another, and that the diverſity of ſounds, gulphs, and runs, which now ſeparate the iſles from one another, and from the neighbouring main land, were afterwards cut through and ſcooped out by the heavy tides, before induration was compleated.

When the formation of the ſuperficies of this globe was ſo far advanced, and the ocean was ſo far purged of the ſtony matter upon the land, as that the tides could not riſe ſo high as to flow or run from eaſt to weſt over the tops of the higheſt mountains, and before they were fallen ſo low as not to overflow the valleys and loweſt hills: In this ſtate of the terraqueous globe, the tides would ſuddenly and impetuouſly ſwell the Atlantic ocean in our longitude, as well as in all others, as they advanced from eaſt to weſt. As theſe ſtill high and powerful tides could not now advance ſtraight forward over the continents of Aſia and Europe, and the range of the Alps, &c. they would advance in the Atlantic ocean into our neighbouring longitudes, with a prodigious head, weight and force, which would ſwell the ocean to the ſouth and weſt of this iſland, &c. to a prodigious height all at once; and theſe monſtrous tides ruſhing down upon the weſt coaſt, would tear up the newly formed land in many places, produce all the ſounds and runs, &c. between the iſles, and then carry the ſuperficies of the ſtrata ſo torn off forward before them, quite through the runs and low paſſages in the mountains, and lodge it where we find it to the eaſtward of theſe iſlands, and of the gulphs through the mountains.

The Atlantic ocean falls now with great weight upon theſe iſles, and upon the weſtern coaſts of Scotland and Ireland; with what prodigious weight muſt we ſuppoſe it would ruſh upon them then, before the force and violence of thoſe high tides were much abated! The Pentland Frith, and other diviſions of the Orcades, and perhaps I may add the Britiſh channel, &c. were cut out at this ſtate of things; and allow me to advance this ſudden and powerful ſwelling of the tides, after the principal part of the ſolid ſuperficies of the globe was formed, as the efficient cauſe of all the iſlands, gulphs and runs, in all parts of the world. I need not enlarge and deſcend to particulars in this inveſtigation. The phænomena are ſo very obvious that they explain themſelves.

I ſee many indications of the iſlands upon the weſt and north of Scotland having at firſt been all one continued land, and joined to the main, and of their being afterwards disjoined from the main and from one another, by the force and weight of future tides. The ſtrata in the weſtern iſlands of Scotland are remarkably flat and regular. I have ſeen ſome of theſe ſtrata ſtretching from one iſland to another, and ſtill preſerving the ſame courſe and declivity in both, and I have ſeen the regular ſtrata in ſome places, ſtretching from the main land to the iſlands, and in other places, from the iſles to the main land. I obſerved before, that the poſition of the ſtrata in the Highlands upon the weſt coaſt, are in general very regular and moderately flat, as well as in the weſtern iſles, and from many ſites in that country, a great number of the iſles ſtill appear all as one land with the main; but upon ſhifting the ſtation, we diſcover the ſounds that part them aſunder. The mountains in the iſles of Skye and Rum, are rather higher than thoſe upon the main near the coaſt, and the ſame may be obſerved of the iſland of Jura, and ſome others;

and it is remarkable, that the weighty and rapid tides which cut the iſlands off from the main, and ploughed the deep channels that divide them from one another, made very great impreſſion upon the weſt coaſt of the main land. This obſervation is evident, from the great number of friths, ſinuſes, or arms of the ſea, which every where cut and indent the weſt coaſt, in ſuch a ſurpriſing manner, that in many places there is not above two or three miles between them, and the moſt of them puſh a great way up into the heart of the Highlands, and many of them appear now like narrow canals ſunk deep among the higheſt of the Highland mountains, and the banks of ſeveral of them are frightful precipices and rugged rocks riſing to an amazing height above.

It deſerves to be noticed, that a conſiderable river runs into the head of every one of theſe canals or lochs, as they are called; and I believe it holds every where, that the larger the river, the the longer the ſalt canal, which ſuggeſts the idea, that the firſt advances of a mighty ſtream tide entering the channels which theſe rivers had begun, in the tender and newly formed ſtrata, would eaſily, by its prodigious weight and force, plough up the bottom of the channel to a great depth; and ſo make room for ſucceeding tides to form ſuch channels fit for the ſalt water lakes, which they now contain. And it is very probable, that ſome leſſer or greater ſtreams of water beginning channels in ſeveral places, would firſt give entrance to the tides which cut aſunder the iſles from one another, and from the main. It is alſo remarkably to the point in this inveſtigation, that the tides in the period I mention, were very near making a great many more iſlands upon the weſt coaſt of Scotland, as there are many places where only a very ſmall tack or iſthmus of land ſeparates the heads of two of theſe lakes, and prevents them from running into one another, and of forming an iſland; ſuch, for inſtance, is the narrow iſthmus at Weſt Tarbet in Argyle-ſhire, not above a mile over, which, nevertheleſs, prevents the large peninſula of Kintyre from being an iſland. There are a great many of theſe narrow necks of land upon the weſt coaſt; and it is remarkable, that in all of them that I have ſeen, a bar of hard rock ſtriking right acroſs the courſe of the tide from the weſtward, has ſtopt its progreſs before it cut a paſſage quite through. I am confident, that if the iſthmus of Darien, and all the other famous necks of land in the world, were examined in this light, it would be found, that there are in them all ſome ſtrata or hard bars of rock, ſtretching right acroſs the courſe of the tide. I have no doubt, that this obſervation will generally, if not univerſally hold true.

We ſee ſuch diſtinct and evident marks of water upon all the phænomena of the ſuperficies of the globe, that it is impoſſible to deny it without being guilty of the moſt abſurd obſtinacy; and it is equally impoſſible to account for thoſe phenomena, without admitting the agency of water; and if we admit of water in different degrees of motion and reſt, then all the phenomena upon and within the ſuperficies of the globe, are eaſily explained in a clear, deciſive, natural and ſatisfactory manner. If we view the ſubject in a proper light, the explanation ſhall be unanſwerable and clear to a demonſtration.

I have heard it obſerved, that the mountains of Britain and other countries ſtretch from eaſt to weſt, but I ſuſpect that this is only a haſty concluſion from a curſory view, of which there have been but too many upon this ſubject. We know with certainty, that the longitudinal bearing of the ſtrata is from north to ſouth, or to the weſt of ſouth, which was the exact line of the tide, and the tide was the efficient cauſe of the diſpoſition of the ſtrata. We have ſeen alſo, that the declivity of the ſtrata in general is towards the eaſt or ſouth-eaſt, and that they riſe and crop out towards the north-weſt, excepting in ſuch low places where there might have been an eddy of the tide, or where it muſt of neceſſity have turned in, or backward towards the land, from ſome neighbouring ſea after the tides began to abate. Now, from the diſpoſition of the ſtrata, we ought to find ranges of mountains ſtretching from north to ſouth, or to the weſtward of ſouth; and I ſuppoſe, if we examine the matter a-right, we ſhall find it ſo in Britain. It is much longer from Thurſo in Caithneſs to the Mull of Galloway, than from Aberdeen-ſhire to the weſt coaſt of the Highlands, and the mountains of Galloway are not the laſt links in the chain from north to ſouth. They reach all the way through Cumberland, &c. to the ſouth ſide of Wales, with no other interruptions than what have been cut through and widened, by the tides ruſhing down upon the land from the Atlantic ocean, as I hinted before. It is true, that many ſingle mountains in a chain, appear in ridges from eaſt to weſt; but it is plain and eaſily conceived, that theſe ridges would be formed by the running of the high tides after the ſtrata were depoſited.

I have mentioned more than once, that in general the ſtrata dip towards the eaſt, and riſe towards the weſt; and I will now obſerve, that it is this poſition of the ſtrata that was the occaſion or natural cauſe of the many abruptions of mountains to the weſt in this country; and many of theſe abrupt precipices will occur in all countries under like circumſtances as with us, and not otherwiſe.

The expreſſion *natural cauſe* may require explanation. When the decline of the ſtrata is towards the eaſt, the eaſt ſide of each ſtratum dips down beneath other ſtrata, and is thereby defended from external injury. The acclivity of the ſtrata, on the contrary, being towards the weſt, the weſt ſide of each ſtratum riſes and crops out to the day, and is thereby expoſed to external injury.

I ſhewed before that the tides in the Atlantic Ocean, after the higheſt lands were formed, would ruſh down with great weight and force upon the weſt coaſt of theſe countries.

Now it is eaſy to conceive that ſuch tides muſt undermine and bring down the outer edges or ſides of the ſtrata ſo expoſed, both upon the weſt coaſt, and as they advanced over the lower lands through the runs mentioned before.

Some of the ſtrata upon the weſt coaſt of the Highlands, and in the contiguous iſles, appear evidently to have been formed by the tides in their return from the weſtern ocean, as hinted before, after they were fallen ſo low, that they could not run over the continents of Aſia and Europe, but could only ſwell the ocean to a monſtrous height, as they advanced weſtward.

The indications I obſerved of thoſe ſtrata being formed in this ſtate and courſe of the tides, is their dipping towards the weſt, contrary to the general dip at a diſtance from the coaſt; and that theſe ſtrata which have the weſtern declivity, are not of the ſame quality and texture as moſt of the mountain rocks, but are many of them more like our grittſtones, freeſtones, and the baſalts, which I ſuppoſe were among the laſt that took their form and ſtation in the wiſe diſpoſition of all the parts of this ſtupendous fabric.

V. I will now advance to the fifth general head of theſe enquiries, which is,

To examine the nature, quality, ſize, and figure of the larger grains and fragments found in the compoſition of our rocks and ſtrata.

In the proſecution of this branch of my enquiries, I will eſpecially examine ſuch parts or ingredients found in the compoſition of the rocks and ſtrata, as are moſt ſingular and remarkable; and the firſt I will take notice of is *talc*.

1. Talc is an exceedingly curious and ſingular foſſil body. I think it may be called an extraordinary one, as there is nothing like it, or that may be compared with it in the whole mineral kingdom, excepting the mica, which, indeed, is

the ſame thing, as mica is nothing but talc broken ſmall. We have no ſuch thing as whole ſtrata of talc; nevertheleſs, we meet with great quantities of it upon the ſurface of the earth, and in the compoſition of the ſtrata.

Although we find no rocks nor ſtrata of this ſingular foſſil, yet it is ſo abundantly diffuſed every where, that we find it viſible to the naked eye, either as talc or mica, in the compoſition of almoſt all ſtrata; and we meet with ſome fragments of it ſo large, that they carry evident marks of the moſt perfect ſtratification in the particular maſſes, and of theſe maſſes being real fragments broken off from their proper beds or ſtrata.

We meet with many other fragments of various ſpecies upon ſthe ace of the earth, but we can carry moſt of them to the rock they belong to, compare them with it, and find them to be the ſame.

But not ſo with the talc. This ſingular foſſil ſtands up for itſelf, and is broken off from no rock or ſtrata now exiſting in this world, and yet there are but few, if any rocks, that do not contain leſs or more of it in their compoſition, either viſible, or in particles too ſmall to be ſeen by the eye. We frequently meet with it in large fragments, imbedded in ſeveral ſtratified mountain rocks. It is a conſiderable ingredient in the compoſition of the granite, and more eſpecially of the white granite. We find that it is a conſiderable article in the compoſition of ſlate, of ſeveral ſpecies of ſchiſtus, and many other argillaceous ſtrata.

The white and the grey broad bedded mountain limeſtones contain a conſiderable quantity of it. We ſometimes ſee it in the baſalts, frequently in freeſtone, and I have ſeen it in lead ore, and in ſeveral other mineral ſubſtances: But the moſt glorious and abundant view that we any where have of the talc, or mica, is in the micaceous mountain rock, where we ſee it in ſuch profuſion, that I am perſuaded it conſtitutes one third of the whole compoſition of ſome varieties of that ſtone, which in a clear day gives the whole rock a bright metallic appearance.

I obſerved before, that ſeveral maſſes of this curious ſubſtance appear ſtratified, and have evident marks of their being broken off from their proper beds. I have ſeen theſe maſſes and fragments in many parts of the Highlands in great profuſion, from the bigneſs of a bean up to the breadth of a man's hand, which had all the marks of being broken off from real ſtrata, as theſe fragments were not only flat, and of a finely laminated ſtructure, but they had alſo ſquare ſides and ſharp angles, ſuch as they ſhould have, if broken off at natural cutters from the original ſtrata. There is nothing in this world that I know of, that exhibits ſuch a finely laminated ſtructure as maſſes of talc; and when we view the ſeveral plates or lamina, after they are ſeparated, it appears the moſt tranſparent and pureſt ſubſtance, excepting the diamond. When this ſubſtance is found in ſuch ſmall ſcales or particles as to be denominated mica, it may then be accounted a part or ingredient in the compoſition of the ſtones in which it is found, which partake of its texture, as we plainly perceive in ſuch ſtones as have a flattiſh running grain or texture. The ſcales of mica likewiſe lie flat in the bed, that is, they lie parallel to the bed of the ſtone; whereas, on the contrary, the larger fragments of talc we meet with in the ſeveral ſtrata and rocks may rather be ſaid to be found in ſuch rocks than to belong to them.

The fragments of talc appear to have no relation to the form and ſtructure of the ſtone, but rather to be accidentally taken up into the compoſition, as they lie promiſcuouſly in the ſtone, without any form or order whatever.

It appears to me highly probable, from the tough flexible quality of the talc, and from the figure of its parts or particles when broken down to mica, reſembling the ſcales of fiſhes, that the mica is a valuable ingredient in the compoſition of ſuch ſtrata as are broad bedded, and of a tough coheſive quality, ſuch as ſlates, flags, &c.

It is not at all improbable, that without mica, we ſhould have had no ſlate nor other ſtones of a ſtrong coheſive quality, which are exceeding uſeful and neceſſary for ſo many purpoſes. On the contrary, our hard ſtones would have been brittle, and would have broken into angular glebes, which would have made them very unfit for bridges, harbours, &c. and we muſt have wanted ſlate.

If we look attentively into the compoſition of ſtones and other foſſils, we ſhall find it a large field, containing a great many curious particulars, ſo that perhaps we cannot paſs through it ſo haſtily as we at firſt intended; there being much in it to attract our attention, and very deſerving our enquiries, if we deſire to be better acquainted with the phenomena of nature. I have already ſhewed, that the mica is a plenteous and an uſeful ingredient, in the compoſition of moſt of our ſtones; and I will now add to it,

2. The quartz, as equally plenteous, curious, and uſeful in the compoſition of our rocks.

Pure quartz, or feldſpat, is perhaps as myſterious a foſſil as the talc. It is true, there is a ſpecies of coarſe-quartzy rock in the Highlands of Scotland diſpoſed in regular ſtrata; but all thoſe ſtrata are evidently compoſed of fine grains of the pure quartz broken ſmall, as is evident by beholding the texture of thoſe ſtrata which reſemble the ſugar loaf. Whereas, ſome ſpecies of the purer quartz, as it is found in the ſtrata, has no viſible grain or texture at all, but is pure, pellucid, and uniform throughout each grain, and there is one ſpecies of it called feldſpat, which exhibits a finely tabulated texture.

I will, in the firſt place, take a little notice of the tabulated ſpecies, of which there does not appear quite ſo much as of the uniform; and then I will take a view of the other ſpecies, which appears to be more widely and generally diffuſed in the compoſition of the ſtrata, and over the face of the earth. The greateſt quantity of the tabulated quartz, or feldſpat, is found in the compoſition of ſome of our granite rocks, and upon the face of the earth in granite gravel, in places where that ſtone has been decompoſed.

Our granite rocks are chiefly compoſed of quartz, ſhirl, and mica. Some of the white granite ſeems to contain little elſe beſides quartz, or feldſpat, and mica, and to have little or no ſhirl in the compoſition. The quartz found in the granite appears either in grains or fragments, and theſe grains and fragments are of various colours, though chiefly red and white, and the ſeveral ſhades and varieties of theſe two principal colours.

It is when the granites are expoſed to weather and decompoſe, that we can diſcern what they are chiefly compoſed of, and in this waſted ſtate of it we ſee very evidently, that the quartz it contains is in grains and fragments, of various ſizes and ſhapes, as well as of various colours. I have frequently ſeen grains or maſſes of feldſpat in the decompoſition, and in the ſections of a maſs of granite, ſo large that they might properly be called fragments.

Theſe fragments are of various ſizes, and they are commonly of a cubical, a quadrilateral, or a rhomboidal figure, with ſharp angles, and theſe are commonly ſeen from the eighth part of an inch, up to two inches and more in length.

Theſe fragments of quartz in granite are all hard and fine, of a pure cryſtalline quality, and they are evidently of a laminated or a tabulated texture, reſembling ſome of our mineral ſpars, only that the quartzy grains are much finer, and more hard and compact than the tabulated ſpars.

The grain and texture is not the only thing remarkable of theſe maſſes of quartz; their cubic and rhomboidal figures alſo deſerves our notice, and to me they have every appearance of being broken off from ſome original ſtrata; which ſtrata are no where to be found in this world, and yet the quantity of this ſpecies of quartz contained in our granite rocks is immenſe.

The quantity of the other ſpecies of quartz, which are found in pure pellucid granules of various ſizes and colours, and of no viſible grain or texture, but which appear uniform and homogeneous throughout, is ſtill more immenſe than that which is of a tabulated ſtructure.

I will note here, that the word quartz is only an improper name given by me to multitudes of fine grains of various colours, ſizes, and qualities, to ſave time. A proper hiſtory of them would fill a large book. Many of them are real gems, and moſt of them perfectly fine and pellucid. I obſerved above, that theſe grains are of various ſizes and colours. I found a moſt beautiful purple-coloured ſand upon the north ſhore of the Moray Frith, in ſuch quantity as to colour the ſhore in ſome places, ſo as to attract my eye from afar. The grains of it were much larger than common ſand. I gathered ſome of it, and upon examination, every grain of it was found to be pure amethyſt. I afterwards diſcovered where it came from, and ſaw ſome of it in the compoſition of very large ſtones, upon the banks of the river Allgrade in Roſs-ſhire, a few miles up the river. I then purpoſed to return and make a further ſearch, to ſee if larger pieces of ſo fine a ſtone could be found among the rocks higher up upon the banks of that river, but I never after had a proper opportunity. There are various grains of ſeveral other colours found in the compoſition of many rocks, and all of them as fine as the amethyſtine ſand now mentioned; but it would be too tedious to enter into minute diſquiſitions of this kind. Therefore, I will take a general view of the moſt common quartzy grains, which are of a white or whitiſh colour, and theſe are the principal articles in the compoſition of the greateſt number of our rocks and ſtrata.

The granite rocks are chiefly compoſed of grains of quartz of various ſizes and colours. The ſandſtones and grittſtones are evidently a compoſition, and grains of quartz are as evidently the prevailing article in the compound. With the grittſtones may be ranked ſome of the coarſer grained mill-ſtone gritts, and part of the finer breccia, as being compoſed of much the ſame materials; the principal part of which is fine, pelluced, water-rounded ſtones of various ſizes and colours, for each of theſe grains is a real, diſtinct, and a perfect ſtone. The rougheſt and ſharpeſt mill-ſtone gritts frequently contain garnets, and many large pellucid granules of other equally fine ſtones of different colours. All the ſandſtones, and others, which contain larger or ſmaller grains of quartz, are to me equally as myſterious as the talc. There are no ſtrata in the world from which theſe ſeveral coloured grains could be broken off, and with which they may be now compared and referred to as their origin. The granite rocks are immenſe. The quantity of rough grittſtones, containing pretty large, fine, and hard pellucid granules of various colours, is very conſiderable; and the ſandſtones, white, red, and grey, is alſo immenſe. Add to theſe the baſalts, and all other rocks containing hard grains of quartzy matter, with the looſe ſands in the Deſarts of Arabia, of Barca, and all the other great ſands in the world, of which we have ſmall ſamples in miniature at home, eſpecially in the north of Scotland. Now, when we throw all theſe together, what a prodigious bulk will it ſwell to! It is ſtill of much greater magnitude than the mica, though we find this too as widely diffuſed. The grains of ſand have long ago been examined by the curious, and they are all found to be fine, hard, pellucid ſtones, having their aſperities and ſharp angles worn off by attrition againſt one another in water.

I now proceed,

3. To examine the ſhirl, which is another curious ingredient in the compoſition of many of our rocks and ſtrata. This remarkable foſſil is called *ſchorl* by the Germans, who give names to all theſe things. Our Britiſh naturaliſts call it

ſhirl; and I think it is called *cockle* by Engliſh miners; or rather, cockle is the name they give to baſalts and other ſtones in which grains of ſhirl prevail. Shirl is a hard and heavy ſubſtance, of a ſhining jet black, and of a glaſſy appearance when found in large grains. The larger grains of it appear to be of a finely tabulated texture, the plates or laminæ of which are very thin and fine, but adhering cloſe together, ſo as not to be of a looſe foliated ſtructure like talc.

This curious foſſil is found generally in a diſperſed ſtate, in grains of different ſizes in the compoſition of moſt of the granites, in all the baſalts, and many other rocks, eſpecially ſuch as are of a granulated texture, and of a black or dark grey colour. Although this ſtony ſubſtance is hard and heavy, yet I am perſuaded that it is more fragile than the quartz; and my greateſt reaſon for alledging its greater frangibility is this, that I have not ſeen ſo many large grains or fragments of it as of the quartz. The largeſt grains of ſhirl that I have ſeen, did not exceed half an inch over any way; whereas I have frequently ſeen fragments of the tabulated quartz or feldtſpat above two inches the longeſt way of the maſs. I have ſeen in ſeveral parts of the Highlands, a ſpecies of granite more black than common, much weathered, and in a ſtate of decompoſition; and in the debris of the diſunited maſs, I could ſometimes

times diſcern that more than one half of it was ſhirl, and the remainder was moſtly quartz.

This was the moſt perfect view of the ſhirl that ever I got; and in this debris, or granite gravel, I have ſeldom ſeen many grains of ſhirl up to half an inch over any part of the maſs, the moſt of the largeſt grains being a little more than a quarter of an inch.

Now, the ſhirl deſerves our attention as well as the quartz and mica. We have no ſtrata of the one more than of the other in this world, and yet the ſhirl, as well as theſe, has evident marks of being remains of the ruins of ſome ancient original ſtrata, of which there are none now to be found, and if there were, it might be a very proper queſtion, How came thoſe ſtrata to be broken to pieces, and the fragments of them to be diffuſed ſo widely as we find them in a diſperſed ſtate in the compoſition of our prevailing ſtrata? That the moſt of our rocks and ſtrata are compoſed of grains and particles of various qualities and colours, is obvious to the ſlighteſt obſerver. We can hardly caſt an eye upon one of our common building-ſtones, without ſeeing this obſervation verified. A due inveſtigation of the principal component parts of our prevailing ſtrata requires more attention. I have beſtowed ſome time and attention upon this matter, and I hope my labour has not been altogether in vain. I have noted a great number of facts, and I hope that I have placed ſeveral articles in a clearer light than they were before, and think that I have made ſeveral obſervations which are new, and which will contribute ſome little aſſiſtance to the ſtudy and inveſtigation of this great branch of natural hiſtory. I have made it evident to a demonſtration, that all the rocks and ſtrata which compoſe the ſuperficies of our globe have been depoſited and formed by water in motion, and at reſt,—that there are upon the ſuperficies of our globe many obvious marks of there having been very high tides at ſome period of time or other, which ſubject I will reſume and conſider more fully afterwards, when I have done with my curſory view of the larger grains which we behold in the compoſition of our rocks, ſuch as the mica, quartz, and ſhirl, and found upon due examination, that although they are the principal parts in the compoſition of thoſe rocks, they, notwithſtanding, did not originally belong to them. In the courſe of my inſpection and enquiries into theſe matters, I perceive that theſe remarkable ingredients in the compoſition of our rocks are inconceiveably finer than the rocks which they compoſe. They have a form and texture of their own, diſtinct from the form and texture of the rocks in which they are found; and there are no rocks in this world of the ſame quality and characters as theſe grains. Our rocks are evidently compoſed of various different grains and particles of divers colours, qualities, and figures; whereas, on the contrary, theſe grains have no viſible particles,—there is no appearance of a compoſition, but a perfect homogeniety is found in all of them. There is indeed ſome little reſemblance between the form and ſtructure of ſome of the largeſt maſſes of theſe, and the fineſt of our laminated ſtrata.

The talc and tabulated feldtſpat are evidently ſtratified as well as our ſlates, coal metals, and others, but there is a thouſand times more diſparity between the fabrication of their ſeveral textures, than there is between the coarſeſt hair-cloth and the fineſt ſilk, or cambric. The ſimilitude between them is juſt ſufficient to ſhew us that water was the agent in the formation of both. There is a homogeniety, a beauty, an uniformity, a fineneſs in the eſſential corpuſcles and textures of theſe ſeveral foſſil ſubſtances, which ſuggeſts to us that theſe are fragments and remains of ſtrata, which were created by the Almighty in the firſt formation of all things. There is an originality and purity in theſe, which ſhews them to be as they came from the hands of God at firſt, when he created all things out of nothing. They are infinitely finer than our coarſe compounded ſtrata. At the ſame time, I am confident that they would not be ſo well adapted for our ſeveral neceſſities as our compounded ſtones. I am fully convinced of the contrary. They are too fine and hard to be worked by us, and too bright and glorious in their colours to be endured by our eyes. The preſent ſtate and appearance of our ſtrata clearly point out to us that the ſtrata which formed the ſuperficies of the globe at the firſt creation, have been ſome how or other broken to pieces; and that the preſent ſuperficies of our globe is compoſed of the fragments of the ancient ſtrata. But before I enter fully into this conſideration, I will juſt hint at a few other articles found in the compoſition of our ſtrata, in order to place them in a proper point of view.

Remains of the teſtaceous tribes, of coral, and other marine productions, have long ago been advanced as proofs of an univerſal deluge, and they are ſo. At the ſame time, I am ſenſible that a very indiſcreet and unmechanical uſe has been made of ſuch proofs, to countenance and ſupport a lame hypotheſis. The evidence of our ſenſes, and the moſt accurate experiments, prove theſe to be real ſhells, and real corals, &c. and no *luſus naturæ*; and therefore, although the earth ſhould be covered with water a thouſand times over, theſe various ſhells, &c. could never enter into the body and compoſition of the ſolid rocks and ſtrata, without the whole of the matter compoſing ſuch ſtrata, ſhells, coral, and all, being blended with the water in a chaotic ſtate. All the ſpecies of ſhells found out of the ſtrata, are alſo found in them; and I have ſeen them in ſome places exceeding numerous, even up to near one half of the whole matter compoſing the ſtone; and moreover, I have ſeen them in ſuch abundance in a pit upon the ſea-ſhore, ſunk a hundred and thirty feet below flood-mark.

Beſides the numerous animal and vegetable ſpoils of the ocean found in the ſtrata, there have alſo been frequent diſcoveries made of their containing numerous ſpecimens of almoſt all the animal and vegetable tribes found upon the face of the earth.

Many weak and fanciful methods have been employed to account for theſe phenomena, without having recourſe to the univerſal deluge; but I will ſay in one word, that it is morally impoſſible to give any account of them, that is not liable to many weighty objections, and that does not infer many abſurdities, without having recourſe to the deluge, or to the chaotic ſtate of the terraqueous globe, which I hint at, and which is really the ſame thing.

I have now made a number of obſervations upon ſeveral of the component parts of ſome of our prevailing rocks and ſtrata. Allow me to collect the moſt of them into one point of view. I have, *Firſt*, examined the talc and mica. *Second*, the quartz, and all the fine large and ſmall grains found in the compoſition of our rocks and ſtrata, and perhaps I ſhould have included many of our gems and precious ſtones under the ſame head. *Third*, The ſhirl, of which we find pretty large grains and fragments in the compoſition of our rocks; but we have no rocks of them in this world. *Fourth*, I have hinted, that our rocks and ſtrata contain in their compoſition, numberleſs remains of all the land and ſea animals and vegetables. I throw theſe altogether in one promiſcuous prodigious heap. The particulars are to be found in books; but my obſervations concerning the quartz, ſhirl and mica, are not to be found in any books that I know of. Now, what ſhall we do with theſe prodigious maſſes of materials which I have collected?

If I am allowed to ſuppoſe, that the quartz, ſhirl and mica, with all the ſamples we find of fine and beautiful grains in the compoſition and decompoſition of our rocks, were once fair and regular ſtrata,—that theſe beautiful ancient ſtrata were ſome how or other diſlocated, broken to pieces, and mixed with the waters of the ocean,—that the waters of the ocean, or the terraqueous globe, were raiſed partly by natural and partly by extraordinary cauſes to monſtrous high tides,—that the ruins of the antediluvian ſtrata were taken up in and agitated by theſe high and powerful tides, until they were mixed with the waters in a chaotic ſtate; and that this chaos was agitated and carried forward from eaſt to weſt by the force and violence of thoſe monſtrous high tides; until, by trituration and grinding againſt one another, in the amazing force of that motion, the fragments of the ancient ſtrata were broken to pieces, and ground down into the grains and ſmall fragments we behold, which were afterwards formed into our rocks and ſtrata, after the violence of the firſt monſtrous tides began to abate; as I deſcribed in the ſecond head of theſe enquiries. Now, if it is allowed, that this account of the matter is natural and mechanical, then we can diſpoſe of all the materials I have collected to the beſt of purpoſes. A ray of light then ſhines upon this dark and difficult ſubject, to ſhew naturaliſts the right path, and a foundation is laid, and every difficulty removed out of the way of the future ſtudy of the mineral kingdom. So that this branch of natural hiſtory may, and I am perſuaded that it will in time become as eaſy, as pleaſant, and as determinate a ſtudy as either of the other kingdoms of nature.

If theſe concluſions are allowed to be juſt and true, then the whole horizon is clear before us; and ſuch a ray of light ſhines upon every part of this hitherto dark and puzzling ſubject, that we can eaſily and naturally account for all the phenomena which we behold upon and within the ſuperficies of our globe. They will all mutually conſpire to account for and explain one another. But, on the contrary, if they are rejected, then we are ſtill in the dark,—we can account for nothing naturally, without being expoſed to a thouſand weighty objections, and without inferring many palpable abſurdities.

I know very well that my obſervations and inferences run counter to the modern philoſophy, which is patronized by many great names in the republic of letters,—but as I am uſed to examine facts, and to take nothing for granted in theſe matters, I pin my faith to no man's ſleeve; I regard not the opinion of any ſect of men, however high their names may ſtand, unleſs theſe opinions be warranted by fact and experience.

The book of nature is open to me as well as to them; and if they contradict what nature plainly and diſtinctly points out, I am not bound to believe them, in direct contradiction to the evidence of my ſenſes. Every thing which I behold in the mineral kingdom favours my perſuaſion of the univerſal deluge; and ſeveral of the phænomena of nature advance a ſtep further, and make it neceſſary. Moſt of the ſtones and other foſſils I take up in my hand are evidently compounded; and I know not how philoſophy will account for a compoſition, without allowing of component parts; and as moſt of theſe component parts are perfect ſtones, this directly favours my obſervations. But I have no talent for ſubtilty of reaſoning; and if I had, my obſervations do not ſtand in need of it. It leads us into darkneſs and perplexity, and in improper hands, leads not only to concluſions which are falſe, but dangerous and hurtful. I will take quite another method. I will muſter up a number of facts in ſupport of my argument, which may be examined by all the world; and if they are not obſtinate and wedded to former ſyſtems, theſe facts will open their eyes to the truth. And if, on attentive enquiry, theſe facts lead to truth, and we are enabled to develope the ſcène of nature, we will rejoice in having found out the right path, and delight in the poſſeſſion of it.

It was the will and pleaſure of Almighty God, (for the puniſhment of a wicked generation of men, but for the good and emolument of the human race in general), to diſſolve the bands of union, and to break to pieces the ſtrata of the antediluvian earth, and to blend and mix the whole fragments of thoſe ſtrata with the ocean, into a ſecond chaos or univerſal deluge.

I will by and by offer a few general obſervations, and I will ſubmit a few conjectures, which may throw light upon ſome parts of this ſubject.

But, in the firſt place, I will examine ſome poſitive proofs of the deluge; which proofs make it abſolutely neceſſary, and which can no way be accounted for rationally, without acknowledging that there was an univerſal deluge; and therefore, I will proceed, according to my method,

VI. To ſelect ſome particular ſtrata for examination, and thoſe ſtrata are the coals and coal metals.

Though I have reſerved the ſtrata of coal, and its concomitant ſtrata, for the laſt of my clear and poſitive proofs of the deluge, yet I do not reckon them the leaſt important and deciſive. I rather chuſe to advance them to the firſt rank, and to give them an eminent ſtation, which they deſerve, among the unqueſtionable proofs of that great cataſtrophe.

Let no man wantonly condemn what I am going to ſay upon this head, before he reads and examines it, becauſe he thinks it is to contradict and oppoſe his preconceived notions. Let him firſt read candidly, and then let him condemn, if he finds that I contradict the phenomena of nature, and that he can give a better account of the matter.

My former diſquiſitions make it evident to a demonſtration, that the ſtrata which compoſe the ſuperficies of our globe were formed by water; and it is evident, that the moſt part of theſe ſtrata are compounded of grains and fragments which have an original appearance, a homogeniety of particles, with evident marks of the fineſt ſtratification, and of their being fragments of a great variety of different ancient ſtrata. Now, if it be acknowledged, that the ſuperficies of our globe was formed by water, I think it is neceſſary either to allow of my account of theſe matters, or to embrace Count Buffon's hypotheſis; and I have made it evident to a demonſtration, that the real ſtructure of the ſuperficies of our globe is abſolutely inconſiſtent with his hypotheſis, which inconſiſtency or incongruity I have clearly proved above. I am perſuaded, from the little I have ſeen and been able to inveſtigate, that when all the ſtrata, and all the phenomena of the ſtrata, and of the mineral kingdom in general, come to be candidly and ſeriouſly examined, they will all of them be found to point out, not a probability only, but even the neceſſity of acknowledging the univerſal deluge, and ſuch a deluge as I haye ſuggeſted.

But I will leave many of theſe phenomena to be examined by others, and will proceed to take the coal under immediate conſideration; and I believe it is out of my power, and out of the power of any other man in the world, to produce a more clear, compleat and deciſive proof of the univerſal deluge than our pit coal; and alſo, of the wiſdom and benevolence of the Supreme Being, in over-ruling the events and operations of nature, and bringing about the good and emolument of man by that extraordinary revolution.

It appears to me evident and paſt a doubt, that timber was the origin and principal matter of which coal was compoſed; and if we allow the origin of coal to be timber, it is impoſſible to give any rational account of the form and ſituation of the ſtrata of coal, without admitting the doctrine of the deluge to be true. That coal was compoſed of timber, is in ſome meaſure evident to our ſenſes. I have ſeen the grain and figure of timber ſo diſtinctly in the ſtrata of coal, as to be certain that it really had been timber, and that it really was when I ſaw it, partly imperfect coal, and partly deſtroyed or ſpoiled timber; and it was this obſervation and diſcovery that firſt excited me to enquire and ſearch out the true origin of coal. I am not the only perſon that has ſeen the appearance of timber in coal. I have, ſince my firſt diſcovery, converſed with ſeveral gentlemen who have made the ſame obſervation; but, for any thing I know to the contrary, I was the firſt that ever attempted to account for the phenomenon, by having recourſe to the univerſal deluge.

Let us take a curſory view of the coals already diſcovered in Britain, in order to give us ſome idea of the quantity of this very uſeful mineral fewel.

What a vaſt number of ſeams or ſtrata of coal are there between Haddington and Edinburgh!—between Edinburgh and Stirling!—in the ſhires of Fife and Clackmannan!—in the ſhires of Lanark, Renfrew, Dumfries, and Ayr, in Scotland!—What an immenſe number in the ſhires of Cumberland, Northumberland, Durham, Nottingham, Stafford, Salop, and all the other coal countries in England and Wales!—and yet what is this ſmall iſland in compariſon of the reſt of the habitable parts of this globe?—But a ſpeck. Neverthleſs, it may juſtly be called a fortunate iſland. It is ſo wholeſome and temperate, and ſo plentifully ſtored with all neceſſaries and conveniencies for the employment and maintenance of multitudes of people in a ſocial and commercial ſtate, that perhaps no iſland nor nation under heaven is in every reſpect ſo well furniſhed, and ſo highly favoured.

Great Britain is a great word in the mouth of a Briton, yet it is but a ſpot when we compare it with the reſt of the world. What a vaſt quantity of coal may we then ſuppoſe to be depoſited in all parts of the ſuperficies of the globe! The quantity muſt be immenſe. At the ſame time, it muſt be allowed that all parts of the globe are not ſo plentifully ſtored with this fewel as Britain. There is almoſt none in Britain itſelf, to the north of the Ochil Hills. There is, as yet, but little diſcovered in Ireland, and ſtill leſs in proportion in many extenſive northern regions.—There are extenſive tracts of granite, and other rocks not commonly aſſociated with coal, in many parts of the globe, where none is to be expected; but after all theſe deductions, the quantity to be found all over the globe muſt be immenſe.

It may be properly aſked, where I am to find timber enough to produce all this coal? This may at firſt ſight appear to ſome abſurd and impoſſible: However, it does not appear to me in that light; and I hope to give a ſatisfactory account of the matter to every impartial enquirer before I quit this point of inveſtigation.

I have good reaſon to believe, (contrary to the opinion of many,) that there was but a ſmall part of the antediluvian earth inhabited; but as I cannot prove thoſe reaſons by indiſputable facts, I will not inſiſt upon them, but will leave it as a ſuppoſition. It was a ſmall part of Aſia, and perhaps a very little of Africa, that I ſuppoſe to have been inhabited before the flood; and the modern diſcovery of human bones in the body of the ſtrata, and blended in the compoſition of the ſolid rocks in the country of Dalmatia, and in ſeveral of the iſlands in the Mediterranean Sea to the weſtward of Aſia, in my thoughts, gives no ſmall ſupport to that opinion. Let us reflect, that Dalmatia, and the iſlands in the neighbourhood of that country, are directly in the run of the high tides, (upon the ſuppoſition of the chaotic ſtate of the earth I inſiſt upon at the deluge,) which at leaſt gives the ſuggeſtion a greater air of probability. For we may juſtly ſuppoſe that all ſuch ſubſtances would be carried ſomewhat weſtward by the high tides of ſuch a deluge, before they would ſettle with other matter, and be lodged in ſtrata. Allow me for once to beg the queſtion, where I cannot avowedly lay claim to it by proving the fact; and let us ſuppoſe, that only a conſiderable part of Aſia, and perhaps a very ſmall part of Africa, were inhabited before the deluge; and in that caſe, by far the greateſt part of the earth lay waſte, and of conſequence, all the uninhabited parts of the earth would be entirely covered with the talleſt and moſt luxuriant growth of timber imaginable; and at leaſt, one half of the inhabited countries would be in the ſame condition. America is a ſufficient proof that the uninhabited and thinly inhabited parts of the antediluvian earth would be ſo covered with timber.

Let us examine how much tall timber will grow upon a ſquare mile of good ſoil, when ſheltered by tall timber on all hands :—Again, how much will grow upon a thouſand ſquare miles, and ſo on, over the greateſt part of the dry land all round the globe; and in this view of the ſubject, we ſhall find that the original ſources of the coal correſpond with the quantity of it in the world.

I will here beg leave to propoſe another probable ſource of coal. I believe I may call it a real one, and that is the antediluvian peat-bog.

I have really ſeen ſtrata of coal that have all imaginable marks of being compoſed or formed of that combuſtible ſubſtance. The colour, quality, and form in the ſtratum, the manner of burning, the aſhes, and every thing elſe relating to theſe coals, look like peat. I have ſeen dried black peats nearly as hard. Theſe coals exhibit no perfect and regular form and grain in working, like other coals, but break into miſhapen glebes, like peat clods broken by water; and I certainly know that peat clods are kept together by the fibrous roots, and are not ſoon diſſolved and mixt with water. The roof or upper ſide of one of theſe ſtrata of coal is not level or plain like other coals, but very unequal; and a ſtratum of clay which is immediately above it, has filled up all the inequalities of the upper ſide of the coal; and when the coal is taken down from it, the clay roof appears with a rough, unequal, imboſſed ſurface.

One of theſe ſingular coals is ſituated at Breich in Linlithgow-ſhire, in Scotland, the property of Sir William Auguſtus Cunningham, Bart.

There are other ſtrata of coal of this quality and deſcription in Scotland, but I only point out this one, becauſe I examined it more minutely than any other.

I know very well that ſeveral naturaliſts, of ſmall knowledge in the mineral kingdom, have advanced the peat-bogs as the effects and produce of the ſtagnations of the univerſal deluge; and peat-bogs, being ſometimes found in low ſituations, with ſeveral feet of earth above the moſs, and a quantity of large timber trees lying in the bottom of theſe peat moſſes, they produce as infallible proofs of the deluge. For the timber, ſay they, is antediluvian, and the clay, or ſediment found above ſome moſſes or bogs, was certainly lodged there by the waters of the deluge; and ſome of theſe moſſes are now diſcovered in maritime ſituations, and by the ſides of great rivers, where the tide flows; and many of theſe are found lower than the preſent high water mark, which they reckon a corroborating proof of the truth of this hypotheſis. Now, as theſe circumſtances ſeem to coincide and depend upon one another, it may not be improper for me to give a brief account of the natural hiſtory of moſſes, or peat-bogs, in order to obviate and remove ſuch miſtakes about them.

All the peat-bogs upon the face of the globe are certainly poſt-diluvian. Many of them are of recent formation, and countleſs numbers are now growing and forming more expeditiouſly than is generally imagined. Decayed and putrefied vegetables is the origin and matter of which all peat-bogs are produced; and decayed and putrefied vegetables may, and do increaſe and accumulate in ſeveral ſituations, and from ſundry cauſes. With reſpect to ſuch as are found as low, or as it is ſaid, lower than the preſent height of the tides, theſe are moſt commonly found in flat bays, and by the ſides of conſiderable rivers, and often not far from where theſe rivers fall into the tide. In ſome places there is a depth of ſediment above theſe low peat-bogs, and good ſoil upon the ſurface, which has been in culture above a thouſand years. Some parts of the Carſe of Gowrie, and of the Carſe of Stirling in Scotland, may be produced as inſtances of this kind, where moſs is found below, and a good depth of ſoil above the peat-bog. The Carſes of Gowrie and Stirling are low plains, the one upon the north ſide of the river Tay, and the other moſtly upon the ſouth ſide of the river Forth; and it is very evident that both of theſe, as well as many others in the ſame country, were formerly the bed of the ſea. The tide runs up now further than any part of theſe two Carſes; and notwithſtanding what many have advanced to the contrary, the tide runs up now every where as far as ever it appears to have run, where the channel it runs in is as ſtrait and free, and not obſtructed and filled up by adventitious matter carried by water, and lodged in the channel. A narrow and a crooked channel obſtructs the free courſe of the tide; and of conſequence the tide is well ſpent before it can force its way as far up as it advanced when the channel was clear and much wider, before it was choaked up and obſtructed by ſand, gravel, or other ſediment from the mountains, which has now filled up many bays, and formed extenſive parcels of new land, through which there is now only room enough, in a winding channel, for the river to paſs which brought it down; but ſometimes is not wide enough for the tide to paſs with freedom, as it did before the bay was filled up. I formerly pointed out the ſource of the depoſition which has filled up theſe bays, and formed theſe carſes, and other new land, viz. the numberleſs rivulets and rills waſhing down the ſoil off the ſides of mountains and higher grounds, and the ſuperficies of the ſandy and argillaceous ſtrata decompoſing and diſſolving with the weather, ſupplies more matter to be waſhed down from time to time. I ſhewed before, that land floods carry down conſiderable quantities of this ſediment, and lodge it commonly where water ſtagnates, and eſpecially about the meeting of the ſalt and freſh water. A ſtream-tide and a ſtrong freſh meeting one another, would throw ſome of this ſediment pretty high into places where there was none before, which might happen to be on a peat-bog, as well as upon any other place.

The phenomenon of the bog itſelf being found ſo very low, is very ſimple and eaſily accounted for. A bank of ſand, or other matter thrown up by the motion of the water in a ſtorm, would form a pool of ſtagnated water behind the bank. This pool or lake being ſhallow, and having a fat ſlimy bottom, a rank growth of many vegetables would ſoon appear, and theſe vegetables decaying annually, would ſoon fill up the water, and form a moraſs, which by degrees would become a peat-bog.

Trees might grow ſo near theſe bogs, as to be in time ſurrounded by their increaſe, which trees might afterwards be blown down by the winds, and covered by the growth and increaſe of the bogs, which in many places is much more haſty than moſt people imagine. Or, the trees might be there before any ſuch ſtagnation of the water happened, and their being blown down might begin a partial ſtagnation, and produce a luxuriant growth of aquatic plants, which would lay the foundation of the bog. When a depth of peat-bog was produced by theſe or ſimilar cauſes, a high tide, and a great land flood, with a ſtorm of wind, meeting and acting with united force, would break over the mound which ſeparated the bog from the waters of the river and tide; and when the barrier which was interpoſed between them was demoliſhed, or a breach made in it, the flood would lay a depth of ſand or mud above the bog, and future floods would increaſe it. Theſe bogs being found now as low as the tide, and the tide ſtill flowing further up in ſuch places, are clear proofs that the ſea is not retreating from our coaſts, as many aſſert.

The rivers carry down the ſpoils of the mountains into the valleys, and the borders of the ſea; and the ſea purges itſelf by the tides, and throws it out again into the bays; and at the influx of the rivers, which really puſhes back the ſea a little from the ſhores, and lengthens the courſe of the rivers. The ſea in ſuch places appears to many to be retreating from our ſhores, but it is not an inch lower upon the horizontal level. It is the ſhores that are enlarging in ſuch places, and new land increaſing with the ſediment depoſited by the rivers. The rivers Forth and Tay, in Scotland, have carried down ſo much ſediment as to produce the Carſes of Gowrie and Stirling; but what are theſe rivers when compared with the mighty floods which derive their ſources from prodigious chains of mountains, and water great continents in their long and weighty courſe!

The effects will be in proportion to the ſize of ſuch rivers, and the length of country which they traverſe. I ſhewed before that the effects of the depoſition of the rivers is very beneficial to ſociety; and that many of the fat valleys where ſome of the moſt wealthy commercial cities in the world now flouriſh, were formed by this ſediment.

It was hinted above, that decayed and putrefied vegetables is the origin of peat-bog; and that decayed and putrefying vegetables may increaſe and accumulate in various ſituations, and from ſundry natural cauſes.

The falling of trees, and even the falling of the branches and leaves of trees upon humid ground, may begin a ſtagnation of more water; and whatever begins a ſtagnation, lays the foundation of a rank growth and putrefaction of vegetables, which is laying the foundation of a future peat-bog.

Great numbers of lakes and marſhes are now making quick advances to become peat-bogs, by the annual putrefaction of a rank growth of vegetables,

tables, and many preſent peat-bogs were formerly lakes and marſhes. There is a beginning of turf or peat-bog in all old fir and pine-woods, among the roots of the trees; and where much fir timber is found in the bottom of a peat-bog, there is no room to doubt that the bog was formerly the ſite of a fir-wood, and that the trees were blown down by violent guſts of wind, and the trees being blown down would encreaſe the ſtagnation and growth; and of courſe, the fallen trees would be ſoon covered with peat-bog. Any other trees falling, or the leaves and branches of any other ſpecies of timber beginning a ſtagnation of water, would lay the foundation of a peat-bog; and whatever remains of the animal or vegetable kingdoms happened to be upon the ſpot when the moſs began, might be found there two or three thouſand years afterwards, as peat-bog is known to be a great preſerver of many different bodies. There is now an annual encreaſe of ſuch bogs, by the decay of various kinds of vegetables, where they are neither waſhed away by ſtreams of water, nor blown away by the winds;—but of all the feeders of peat-bog, the moſt common and the moſt plenteous is heath, and heath is found plentifully in all cold countries, and eſpecially upon poor, ſandy, gravelly, and boggy ſoils. I have ſeen many peat-bogs with heath growing upon them, the ſurface of which conſiſted of a foot and a half or more of the branches, bloſſoms, and ſeeds of the heath, apparently not in the leaſt decayed.

The ſecond ſtratum down conſiſted of the ſame matter beginning to decay a little. The third courſe produced bad, light, imperfect peat, called flow-moſs in Scotland. The fourth, and ſo on, ſtill better and better peat, the farther down, until it became, at a ſufficient depth, perfectly black, and of a cloſe texture, being well digeſted peat-bog.

This is a ſufficient deſcription of Moſs-Flanders above Stirling,—of the moſs of Kintraw in Ardnamurchan,—of the Solway moſs, and of almoſt all the moſſes in the Highlands of Scotland. The fibres, bloſſoms, and ſeeds of the heath which fall off, is a copious annual ſupply; and the depth of moſs produced by theſe ſupplies is very great in many places which I have ſeen. In this inſtance, the cauſe and the effect tally exactly. But to leave this digreſſion:—The other coal metals, or the ſtrata which accompany coal, are as clear a proof of the univerſal deluge as the coal itſelf, or nearly ſo. Many of theſe have a ſmall quantity of the coal between their folds and lamina, and in ſmall neſts within the ſolid parts of the ſtrata, and theſe concomitants of the coal are all as regularly ſtratified as any other claſs or aſſemblage of ſtrata whatſoever. There is one among theſe beſides the coal, which deſerves particular notice, and that is the ironſtone. The ironſtones of the coal-fields are diſpoſed in regular ſtrata, and there are in ſome coal fields a great number of ſtrata of ironſtone. Theſe ſtrata of ironſtone are generally thin, few of them being a foot thick, and ſome of them not above an inch. The medium thickneſs of the bands or ſtrata of ironſtone in the coal metals, are from two to five or ſix inches; but notwithſtanding their being ſo thin, they are nevertheleſs as regular ſtrata as the coals themſelves, and ſpread as far every way as any of their concomitant ſtrata.

Now, every intelligent unprejudiced naturaliſt, who has taken any notice of the order and diſpoſition of the ſeveral ſtrata in a coal field, muſt acknowledge with me, that thoſe ſeveral ſtrata were ſpread out, and formed in the order we find them, by ſucceſſive tides, or by ſimilar ſtreams of water, bringing the matter and depoſiting it in regular ſtrata. The order in which they are placed, ſtratum ſuper ſtratum, promiſcuouſly, in reſpect to the laws of gravitation; the heavy, the light, and thoſe of medium ponderoſity, being all blended together, without the leaſt regard to gravitation, makes it evident to a demonſtration, that they were depoſed in the order we find them by ſucceſſive ſtreams of water. Any other way of accounting for this depoſition, muſt be unmechanical and imperfect, and will not agree with the phenomena of nature. The bands of ironſtone in the coal fields are commonly found in thoſe black and grey argillaceous ſtrata called till or blaes, which generally accompany coal; and we frequently find two or three, or more, thin ſtrata of ironſtone in one thick ſtratum of blaes, which is the name given by Scots colliers to theſe argillaceous coal-tills. But it ſhould be obſerved, that all the ironſtone of the coal-fields is not ſtratified, nor found regular and continuous in the manner of any regular ſtrata. We often find and work ironſtone in nodules, balls, and glebes, which are depoſited promiſcuouſly without any regular order, in pretty thick and generally ſoft ſtrata of the coal-till or blaes. This ball ironſtone is very commonly found in ſoft argillaceous ſtrata, of various colours beſides the black, as whitiſh, aſh-coloured, and various ſhades of grey.

Theſe glebes and balls of iron are found in this manner blended in the argillaceous ſtrata, of all ſizes, from the bigneſs of walnuts, up to maſſes of a hundred pounds weight. The balls are found in leſs or greater quantities in different ſtrata of blaes; and frequently in leſs and greater quantities in different parts of the ſame ſtratum.

This ball ironſtone is always of the ſame quality as the regular ſtrata of ironſtone found in the ſame coal-fields; and the balls and glebes always appear water-rounded, being either found in ſmooth roundiſh balls of various ſizes, or elſe in flattiſh glebes with obtuſe angles or ſmooth rounded edges. Now the ſituation, order and figure of this ball ironſtone, is another proof of ſucceſſive tides in the formation of the ſtrata. This glebous ironſtone was firſt of all formed in regular ſtrata of various degrees of thickneſs; but before induration was compleated, a ſtream tide, accompanied by a ſtrong wind, has plowed up and torn off part of the ſuperficies of the ſtrata of ironſtone and others already formed; the fragments of which ſtrata, when torn off, were eaſily rounded by rolling and attrition in the water, before they were perfectly indurated; and theſe fragments were afterwards depoſited by ſucceeding tides in the ſoft argillaceous ſtrata already mentioned; which ſtrata of coal-tills, holding glebes of ironſtone, and ſuch other ſtrata as are found above them, muſt have been formed later than the regular ſtrata of ironſtone from whence theſe glebes were torn off. That they were torn off from the ſuperficies of regular ſtrata, is evident, from the glebes and balls being of the ſame colour, quality and texture as the ſtrata, even to the niceſt exactneſs when compared, and from the thickneſs of the glebous maſſes correſponding with the thickneſs of the ſtrata; and in ſome beds of till, the glebes of iron have evident marks of the ſtrata from which they were broken remaining.

The richeſt and pureſt ironſtone of the coal-fields is generally of a fine texture, commonly riſing in ſmall angular maſſes from the ſtratum, fragile, and eaſily broke into ſmall angular maſſes of different figures; and we find the pureſt and richeſt ball iron in exceeding ſmall maſſes, imbedded in the ſtrata of coal-till, of various colours. On the contrary, ſtrata of inferior quality have a coarſe grain and texture, are more ſtrong and coheſive, and riſe in larger glebes in working it from the ſtratum. Some of the inferior kinds, when the ſtrata of ironſtone are not above three or four inches thick, riſe in broad flat cakes or glebes; and I have frequently ſeen them in as broad and flat maſſes lodged in the coal-tills, with only the edges or ſharp angles a little worn off. Such glebes of ironſtone as have been broken off from thinner and thicker ſtrata, ſtill retain evident marks and characters of their ſtratified ſtate, as the various maſſes and fragments clearly diſcover the bed of the ſtone, having only the aſperities and ſharp angles worn off. I have endeavoured to explain this phenomenon with ſome degree of perſpicuity and preciſion;

becauſe I think it deſerves attention, being a clear and convincing proof of the formation of the ſtrata, by ſucceſſive tides or ſtreams of water in motion.

I obſerved before, that the various ſtrata found in coal fields, are as finely ſtratified, as regularly ſpread out, and as equally thick in continuation, as any claſs or aſſemblage of ſtrata whatever; and I will now obſerve, that the coal itſelf is likewiſe as fairly ſtratified, and as regular as any of its concomitant ſtrata. Many beds of coal are ſo finely ſtratified, that they really are of a laminated ſtructure, the plates or different lamina being thin and ſplitting regularly in leaves of equal thickneſs, the whole breadth of the largeſt maſſes; and I have frequently ſeen ſeveral ſeams or beds of diſtinct kinds or denominations, and of different qualities of coal, lying regularly, ſtratum ſuper ſtratum, in one individual thick bed of coal, ſuch as ſplint coal, or ſtone coal, parrot, or cannel coal, cherry coal, and various mixtures of the roch coals of different and diſtinct grains and textures, all of them regularly diſpoſed one above another in the ſame individual ſtratum of coal, below ground, without any ſtone or till, or other heterogeneous matter interpoſed between them. Now, this is a clear proof of the agency of water in a gently flowing motion. If theſe northern regions were not inhabited, they would ſoon be overgrown with wood, and eſpecially with pines, or fir wood. Tar is extracted from fir wood; and it is remarkable, that of late years it has been diſcovered that a ſpecies of tar can be extracted from coal, which is procured in great abundance by a ſort of diſtillation. I cannot help thinking that this known fact is a good collateral proof of the antediluvian timber being the origin of coal. This mineral tar has a fetid, diſagreeable ſmell, which, no doubt, is cauſed by its being combined with vitriolic and other heterogeneous particles.

The coal from which this tar is extracted being in a mineralized ſtate, and mixed with various heterogene matters, we cannot expect this pitchy extract to be as ſimple and pure as the reſins of timber, but they are really of the ſame quality.

I am really concerned for the honour of the coal. It is an intereſting ſubject, eſpecially in Britain; and as very little to the purpoſe has been ſaid about it hitherto, that I know of, I reckon the ſubject my own, and therefore I wiſh to be its faithful hiſtorian. I have endeavoured to be as clear and diſtinct as poſſible in explaining its principal phenomena in a former volume; and I hope that I will be underſtood. Nothing can make me believe, nor even ſuſpect, that ſuch a wonderful natural production as coal, of ſuch characters and properties, could happen by chance.

Let us ſuppoſe that all the particles of matter of which coal is compoſed to be really exiſting; and let us ſuppoſe them to be thrown, or any how carried into the ocean, according to the wiſh of the modern philoſophy; if theſe particles are left there to chance, when blended with the particles of an infinitely greater quantity of matter entirely of a different quality, (which matter we find diſpoſed in different ſtrata along with the coal,) the known laws of gravitation would render all theſe combuſtible particles entirely uſeleſs to us. According to thoſe laws, the ſtony and metallic particles would either be found mixed and compounded with the coal, or rather, they would all ſink down under it, in the order of their ſpecific gravities. In either caſe we ſhould have no coal.

I think that I made it ſufficiently evident before, that neither coal, nor any other regular ſtrata could poſſibly be formed by ſubſidence in water, that is, by the particles of matter ſubſiding to the bottom of the ocean, without a miracle. That I may illuſtrate this matter as much as poſſible, I will further obſerve, that we have occaſion to ſee many natural and artificial operations, which clearly evince the truth of what I aſſert. A recital of one of theſe may help to throw light upon this part of our ſubject, and to convince the candid that the coals certainly could not be formed under the ſea.

We know by experience that when grains or particles of different degrees of gravity are any how jumbled or agitated in water, the more ponderous always ſink down below the lighter. I will give a complete inſtance of this in an artificial operation. The ſlime ore, or ſmaller grains which the water inevitably carries away with it in dreſſing the ores of tin and lead, &c. is ſaved in ſmall ponds, or holes dug in the earth, in which the water that runs from the waſhing operation ſtagnates, and the ſlime carried with the water falls to the bottom. When theſe ſlime pits are full, the ſtream of water is turned off, and the ſludge is thrown out to dry. The mineral waſhers have many nice and curious methods of dreſſing this ſediment, in order to ſeparate the heterogeneous particles from the metallic.

The beſt part of the tails (as it is called in the art of dreſſing ore) contains a great quantity of pyrites and other heterogeneous matter. Some of theſe tails they cannot clean by any ſtream of water, the heterogeneous being nearly of the ſame ſpecific gravity as the metallic particles, and therefore they are obliged to take another method to clean it, which is called turloobing, or tozing, and it is performed thus :—They fill a large tub or vat about half full of water. A man of ſkill takes a proper ſhovel in his hands, with which he brings the water in the vat to a pretty quick circular motion, and then one or two men begin to lift the matter, upon which the operation is to be performed into the vat, rubbing their ſhovel fulls againſt the inſide of the tub, to the end it may fall into the water in a looſe pulverized ſtate. The man with the ſhovel continues to turn the whole round, and the others heave in the matter untill the vat is full, and then the ſhovel is drawn out, and they inſtantly take bats in their hands, and beat the outſide of the vat with the battons for a conſiderable time, until the whole matter ſubſides in the water, and becomes conſolidated into ſo hard a body, that it requires a ſharp edged ſhovel to cut or pare it out. When the ſords or water is thrown off, they begin to take out the matter, paring it away horizontally, and there we ſee the laws or effects of gravitation in the utmoſt perfection, and preſerving the niceſt exactneſs imaginable. A conſiderable quantity is thrown away off the top, and then they ſeparate what contains any metal into ſeveral parcels, according to the quantity contained in each. As they come down to the good ore, they try it by vanning with a ſhovel to know when it is clean enough; and I have ſeen half a ton of clean ſlime ore in the bottom of the vat. We cannot expect the ſame nice exactneſs in chance work; however, particles of matter mixt and agitated in the waters of the ocean, and afterwards ſubſiding to the bottom, comes as near the tozing operation as any thing that can be imagined in nature or art; of conſequence, coal, and other diſtinct ſtrata, could not be formed by ſubſidence in the waters of the ocean, without a miracle; and I am not willing to admit or allow miracles to be introduced, where the operations of nature, and the agency of ſecond cauſes, will do as well. I obſerved already, when viewing the coal metals, that the laws of gravitation were not conſulted, nor admitted in the formation of thoſe ſtrata; and therefore it is neceſſary for us to acknowledge that they were formed by the flowing of ſucceſſive tides.

I have already made it pretty evident that the greateſt part of the ſurface of the earth, before the deluge, was covered with a luxuriant growth of tall timber; that this antediluvian timber is the origin of our pit coals, and that it was a ſufficient and an adequate ſource of all the coals in the world. I am of opinion that the antediluvian timber floated upon the chaos, or waters of the deluge, until the ſtrata of the higheſt mountains were formed, with much of the other ſtrata in our ſight; and that during the height of the deluge, and the time in which the greateſt part of the ſtrata were forming, the timber was preparing and fitted for being depoſited in ſtrata of coal; and that the coals, with their concomitant ſtrata, were among the laſt that were formed. But how, and by what means, every thing in this great work was fitted and carried on, belongs to higher wiſdom and intelligence than mine to explain. However, we may examine what we can ſee with our eyes, and what is to be ſeen we may inveſtigate by the aids of philoſophy; and it is allowable for us to draw ſuch inferences as naturally and inevitable reſult from our obſervations and diſcoveries.

Whereſoever I have ſeen the ſtrata of the coal metals terminate, and the ſtrata of the mountain rocks commence in their place and ſtead, whether in the longitudinal line of bearing, or acroſs the ſtrata, the coal metals always ride uppermoſt,—are troubled, confuſed, and good for nothing, and commonly dwindled away to little in thickneſs; whereas, on the contrary, the ſtrata of the mountain rocks emerge from under the diſturbed coal metals in full perfection of quality, ſtrata, and bearing, &c. and therefore I am obliged to conclude that the ſtrata of coal, and their concomitants, were among the laſt which were formed.

I have frequently ſtood upon the ſummit of a high mountain in a clear day, and taken a general view of the outlines of this great ſubject; and from ſuch elevated ſituations, and indeed every where elſe, I ſee deep and evident marks of the amazing effects of the high diluvian tides, even after the higher mountains and other elevated parts of the earth were formed. All the long and deep channels through chains of lofty mountains, were cut out by the running of theſe weighty tides. All the gulphs and deep bays upon the face of the globe, were ſcooped out by the prodigious weight and force of the violent agitation and progreſs of the tides of the ocean from eaſt to weſt.

A philoſopher who is much out of doors, and traverſes mountainous countries,—who admires theſe grand and magnificent ſcenes of nature, intent upon diſcoveries of truth, and who is not wedded, or rather enſlaved to ſyſtem, cannot fail of ſeeing the evident marks of theſe tides we are ſpeaking of upon the whole varied face of the earth. The Mediterranean, the Red Sea, and all the other inland narrow ſeas, were cut out and produced by the violent progreſſive motion of thoſe high and weighty tides. It was the weight and force of theſe prodigious tides, even after the mountains and elevated plains were formed, that has cut out all our ſounds and deep channels between the continents and iſlands,—that has cut through the iſlands, and diſſeminated them over the face of the deep.

The weight and force of tides, which perhaps were ſeveral miles of perpendicular depth, have made mighty efforts to waſh away the whole face of the dry and ſolid land, and mix it again with the waters into a chaos.

The weight and force of theſe tides were ſo very great, that they have nearly cut a paſſage through the middle of both continents. In their progreſs from eaſt to weſt, they have plowed up the channels of the Red Sea and the Mediterranean, which was a mighty effort to diſſever the old continent, and gain a clear paſſage to run quite through, and this paſſage was nearly compleated; nothing but the narrow iſthmus of Suez remaining to connect Aſia with Africa. Similar marks and effects of theſe immenſe tides are as evident in the new continent as in the old. The gulph of Mexico upon the one ſide, and the bay of Panama upon the other, are ſufficient inſtances to ſupport this aſſertion, where nothing but the iſthmus of Darien remains to connect North and South America into one continent. It is ſomething ſingular and curious, that both the iſthmus of Suez, and that of Darien, are very near the ſame breadth, being each of them about ſixty miles over.

We ſhall attempt to throw ſome more light upon this great ſubject, by a few general obſervations. It was hinted before, that the gulphs were ſcooped out, the iſlands diſſevered from the continents, and from one another, and the ſounds and channels were plowed up by the weight and force of the high tides, after the higheſt mountains, and other elevated parts of the globe were formed, and even after the tides were fallen ſo much as not to flow over the moſt lofty mountains and elevated plains.

In the height of the chaotic ſtate of the terraqueous globe in the univerſal deluge, the tides flowed clear over every thing from eaſt to weſt, without any obſtruction; and even after numbers of the higheſt mountains were formed, the tides were ſtill high enough to flow clear over the main parts of both continents, though not over the ſummits of the higheſt mountains; but when more elevated lands were formed, and the ſtratification of the ſuperficies of the ſolid parts of the earth were pretty far advanced, the tides would then fall gradually and proportionally lower.

I ſhewed before, that the high tides, after the land began to be formed, purged the ocean of the earthy matter, and every ſucceeding tide laid more ſolid matter on the face of the ground; which was ſpread out in regular ſtrata by the ſtream or flowing motion of the tides which brought it there. I alſo obſerved before, that all chains of mountains were at firſt elevated plains, and that it was very high tides flowing and running over them that had cut and diſſevered their ſummits, and excavated their glens and deep valleys.

The marks of forcible runs of water is evident in all the irregularities of the mountains. But all theſe primitive elevated plains were not cut through in a thouſand places like our mountains, nor disfigured, but remain to this day; ſuch, for inſtance, are the elevated plains of Abyſſinia in Africa, of ſome of the ſouth-eaſtern parts of Tartary or Buckaria, and the elevated plains of New Granada in America, all of which are countries of great extent, and raiſed higher above the level of the ſea than our European mountains. If all the mountains were elevated plains at firſt, and if the elevated plains now mentioned are as high above the level of the ſea as our mountains, how comes it to paſs that theſe remaining high plains were not cut through and diſſevered by horrid gulphs and valleys, like our rugged miſhapen mountains? I anſwer briefly, the tides fell ſo low, by diſcharging and lodging much earthy matter upon the land, immediately after the formation of theſe elevated plains, that the water could not flow often enough over them to cut them aſunder and disfigure them; and and when the tides flowed over them no more, they could not be plowed up and broken to pieces like our mountains. But when all the higheſt mountains and the elevated plains appeared at all times above water, and were no longer overflowed, not even by ſtream tides, it was then, when much dry land ceaſed to be overflowed by the tides, that the ſtill comparatively high and forcible tides made ſuch powerful efforts to cut through the continents and iſlands in all parts of the world. It is well known, that the tides riſe high and run with great force in the torrid zone. The high chaotic tides would run with proportionally ſtill greater force there than at preſent; and it is in the torrid zone that the greateſt marks are found of thoſe high and powerful tides. The diluvian tides ruſhing powerfully from eaſt to weſt againſt the old continent, would be received and repelled by the elevated plains and chains of mountains, reaching from Abyſſinia to the ſouthern parts of Monomotapa, and they would be repelled to the north by numerous chains of mountains and high lands, ſtretching from Cape Comorin to the northern extremity of the Old Continent. When theſe chains of mountains and elevated plains ſituated to the ſouth and to the north of the Red Sea, were now out of danger of being overflowed any more, the weight and force of the high tides of the Indian ocean then ruſhed powerfully againſt the middle of the Old Continent, where the land was not ſo high as upon both ends, and they have made ſad havock of the low lands of the middle of the continent, and very nearly effected a paſſage quite through. The immenſe extent, and infinite number of the Eaſt India iſlands which are diſſevered from the continent, and from one another, is a clear proof of the prodigious weight and force of the high tides of the Eaſtern ocean againſt the land. The effects of theſe tides againſt the eaſt and ſouth-eaſt ſides of the continents, have left deep and indelible marks of their powerful efforts: They have puſhed far into the main land, in the gulphs of Siam and Bengal, and ſtill farther in the gulph of Perſia; but they were every where repelled by high lands, until they came to Babelmandel, and there they entered the Red Sea, paſſed over the low lands of Egypt into the Mediterranean, and ſo quite through the Old Continent into the Atlantic ocean, and the high tides continued to flow through the middle of the continent until they fell nearly as low as at preſent; and then this paſſage was ſhut up and barred againſt the common tides by the iſthmus of Suez, and the main ocean was obliged to flow ſouth about by the Cape of Good Hope, before it could come into the Atlantic.

While the diluvian tides continued ſo high as to paſs over the land of Egypt into the Mediterranean, the run of the Mediterranean weſtward joining the tide of the main ocean upon its entering the Atlantic, would make a very ſtrong, weighty and powerful tide in the gulph of Mexico, and the effects correſpond with our idea of the weight and force of theſe tides. The numerous and extenſive range of the Weſt India iſlands, and the gulphs of Maracaybo, Darien, Honduras, Nicaraqua, and others, are ſufficient proofs of the force of the Atlantic tides, and of their efforts to find or to cut a paſſage through the middle of the New Continent as well as the old. The later high tides paſſed over the iſthmus of Darien in the New Continent, as well as over the iſthmus of Suez in the old, and ſimilar circumſtances may be obſerved in both theſe paſſages. The New Continent is divided into two great parts, by the iſthmus of Darien, in the ſame manner as the Old Continent is divided in two by the iſthmus of Suez. The iſthmus of Suez and of Darien, though in two different continents, and removed at ſuch a vaſt longitudinal diſtance from one another, are nearly in the ſame parallel of latitude, which is about ten degrees north of the equator. It is evident, that when the land was moſtly formed, and the tides were fallen conſiderably lower, though yet ſtrong and violent, yet in this ſtate they could not make way over the elevated plains of New Granada, and the lofty and extenſive range of the Cordilleras and Andes, to the ſouth of Darien, nor over the immenſe and elevated countries of Mexico, and other parts of America to the north of Darien; and therefore, the iſthmus of Darien, or Panama, was the only paſſage which the later high tides could find, for the ocean to paſs through the middle of the New Continent, as it had paſſed through the middle of the old; but when the ſea was thoroughly purged by the tides of earthy matter, and the dry land was all formed, the tides then fell ſo low by degrees, that they could not paſs over Darien, no more than they could paſs over Suez.

From the examination of theſe facts and circumſtances, it is evident, and deſerves to be remarked that the middle of both continents were at firſt formed lower than both ends; that is, from the iſland of Scotoro upon the eaſt, to the bay of Cadiz upon the weſt of the Old Continent, was all low land, much lower than the extenſive lands to the north and ſouth of this low tract, over which the diluvian tides paſſed for ſome time after they were fallen too low to paſs over the whole extent of the Old Continent; and in this Mediterranean paſſage the tides plowed a deep channel all the way through from eaſt to weſt, excepting the narrow iſthmus of Suez. The middle of the New Continent was alſo at firſt formed low land, as well as the old, and very nearly in the ſame parallel of latitude. The firſt low plains in the middle of the New Continent ſeem to have reached from the iſland of Porto Rico to the bay of Panama, over which the ſtrong confined tides made way, and cut a paſſage quite through the middle of the New Continent, excepting the narrow iſthmus of Darien. It may be difficult to give a ſatisfactory reaſon, why the middle of both continents ſhould at firſt be formed much lower lands than the two ends; however, I will offer what occurs to me in explanation of this ſingular fact.

It is allowed by all, that the torrid zone, or the equator, is the higheſt part of our globe; of courſe, the zone or girdle of the equator is longer than any other zone of the earth. This greater length of the zone gives the equatorial tides a greater length of ſpace to paſs over in every revolution, than in the other diviſions of the globe; and moreover, the torrid zone being under the perpendicular rays of the ſun, the powers of attraction are greater there than in any other diviſion of the globe.

When the land and water were blended together in the chaotic ſtate of the deluge, the powers of attraction would raiſe the chaotic tides proportionally higher in the torrid zone, than in any other parts of the globe. The Cordilleras, and other exceeding high mountains, and the elevated plains of New Granada and Abyſſinia, &c.

make it evident that the tides were exceeding high in the equatorial regions. Theſe high tides having ſuch a vaſt zone to encompaſs in equal ſpaces of time with the revolutions of the tides, without the tropicks, where the zones are much ſhorter, it is evident that the equinoctial tides muſt run with a ſtronger and ſwifter current than at the tropicks, and ſtill much quicker than in the temperate and frozen zones of the globe. This is neceſſary from the nature of things. The revolutions of the tides being performed in the ſame length of time in all parts of the globe, the equatorial tides, which had by much the longeſt courſe, muſt of neceſſity run the quickeſt, in order to arrive at the goal in the ſame ſpace of time as thoſe in the ſhorter courſe. It is obſervable of a river in a land flood, that the middle of a ſtream or current runs or ruſhes forward boldly in a high and ſurgy ridge, and ſeems to haſten down to the ſea, regardleſs of obſtructions, which are frequently ſurmounted or ſwept away to the ocean. But the ſides of the river in flood do not run quite ſo faſt. The main head or current ſeems to cut its way, and paſs through the middle of the river, which it leaves to follow at more leiſure; and this is frequently ſo very evident, that eddies are formed in many places upon both ſides of the main ridge or channel in the middle. We muſt compare great things with ſmall, to enable us to conceive proper ideas of the great works of God. Let us then ſuppoſe, that the diluvian tides at the equinoctial line would ruſh forward in a high and bold ridge and current, like a river in flood, and then we ſhall be able to comprehend the reaſon, why the land is lower near the equator, than in the reſt of the torrid zone upon both ſides. The tides in this track would always run with a current too ſtrong, weighty and ſwift, to allow mountains of granite and others to ſubſide, or regular ſtrata to be formed to any conſiderable height. But this bold and mighty run of the main current at the equator, would produce eddies at ſome diſtance upon both ſides, where mountains of granite would ſubſide; and ſtrata would be formed by a more temperate and leiſurely current and motion of the tides.

I obſerved already, that the chaotic tides ruſhed forward from eaſt to weſt in two great guſhes in the twenty-four hours; that the time of reſt between each guſh is high water, and the places of reſt, the two great continents: I mean, during the height of the deluge, or chaotic ſtate of the terraqueous globe. Upon this ſuppoſition, the tides in the intervals of each guſh, at high water, would reſt a little upon each continent, or at leaſt, they would not ruſh forward ſo precipitately for ſome ſpace of time at the turn of the tide.

This ſmall and partial interval of reſt, or of ſlower motion during the height of each tide, would be more conſiderable at ſome diſtance from the equator upon both ſides, than immediately under the line, which intervals of time would not be loſt. The formation of the ſolid land would advance rapidly in theſe times and places. But under the equator the tides would not have much time to reſt, the intervals would be leſs conſiderable than upon both ſides, and therefore the ſuperficies of the globe was not formed ſo high in this great run of the tides over the Old and New Continents, as at ſome diſtance upon both ſides. It was hinted before, that in conſequence of theſe low parts in the middle of each continent, the ſtrong tides towards the end of the deluge, which were not now high enough to flow over both ends of the two continents, paſſed for a conſiderable time afterwards over the middle of them, and ruſhed quite through from ſea to ſea. And theſe weighty and forcible tides have made terrible havock in the middle, or near the middle of both continents. The Red Sea, the Mediterranean, and Black Seas, and the gulphs of Venice, &c. are ſufficient proofs of the ravages of thoſe tides in the middle of the Old Continent.

I ſuppoſe that the long chain of iſles reaching from the iſland of Trinidad, upon the ſouth-eaſt, to the Streights of Bahama, upon the north-weſt, were formed at firſt in one continued plain or regular connected piece of land of no great height, but containing however ſome conſiderable mountains, which ſtill remain in St Domingo, Cuba, Jamaica, and in ſome other iſlands, but that the high tides of the Atlantic Ocean cut through, and diſſevered them from the Weſtern Continent, and from one another. When ſo much of our dry land was formed, that the tides did not riſe ſo high as to paſs freely over the ends of both continents, but ſtill continued to run through the middle of them, there would then a ſtrong and powerful tide pour into the Atlantic from the great South Sea, between the Cape of Good Hope and Cape Horn; and when this great and weighty tide was met and joined by the powerful current which ruſhed through the middle of the Old Continent, the united force and weight of both, when joined, would have powerful effects upon the lower parts of the New Continent. It was then that the long ſtretch of land reaching from the river Oroonoko to Florida, was plowed up and torn to pieces by the mighty efforts of thoſe tides, to make a free paſſage through the middle of the New Continent, which was very nearly effected; nothing being left between the two ſeas but the narrow iſthmus of Darien.

The debris or ruins, that is, the earthy matter which the tides plowed up and ſwept out of the numerous ſounds and channels which ſeparate the Caribbee and other Weſt India iſlands, was carried by the tides over the iſthmus of Darien, quite into the South Sea, where it ſubſided here and there in ſmall patches, and formed the numerous ſmall iſlands of the ſouth ſea, and ſome of the low plains of Peru and Chili. When thoſe ſtrong tides of the Pacific Ocean ruſhed between Cape Palmas and Cape St Roch into the Atlantic, the courſe of thoſe tides in the Atlantic would be northerly or north-weſt; but when the Mediterranean tides, which iſſued out by Gibraltar, met and joined the tides from the ſouth, the current from the Mediterranean would turn the weight of thoſe tides to fall upon the Caribbee iſlands, in their way to paſs through the gulph of Mexico, and over the iſthmus of Darien.

The weighty tides which came between the two continents into the Atlantic, have cut deep into the land in many of the northern parts of Europe and America. The effects of theſe powerful and weighty tides upon the inſide of the northern parts of the globe, are very evident in the many ſeas, bays, and gulphs which are ſcooped out of the boſom of the northern parts of both continents; but it does not appear that they found, nor that they made a paſſage quite through the dry land in the northern parts of the earth. Theſe tides might find low lands in the north, over which they might paſs for a long time, as they paſſed over the iſthmus of Suez, and of Darien; but, however that might be, I am perſuaded that all the paſſages of the tides in the north are now barred up, as well as thoſe further ſouth.

I have ſeen the narrow iſthmus at the north end of Cantire, which joins that peninſula to the main land of Scotland; and I have ſeen many other low and narrow bars between two ſeas or bays, over which the high tides I am ſpeaking of paſſed freely; and I have every where obſerved, that theſe low and narrow necks of land conſiſt of exceeding hard rock, which the moſt weighty and forcible tides could have no effect upon to wear them down; and this is the very cauſe which prevented the peninſula of Cantire, as well as many others from being iſlands.

This iſthmus or rock which joins Cantire to the main land, is not above a mile over at high water in ſtream-tides; and I believe that the higheſt part of the rocky bar is not thirty feet above flood mark.

The Buccaneers and other voyagers tell us that the iſthmus of Darien in America is rocky ground; and I am certain it muſt be ſo, and that thoſe rocks are very hard and ſtrong; otherwiſe the forcible tides which ruſhed from the Atlantic, over that iſthmus, would have cut through and torn away this bar, and made a deep and wide channel between the gulph of Mexico and the bay of Panama. I know nothing about the natural hiſtory of the iſthmus of Suez; but we are well informed that Egypt abounds in excellent granite quarries; and therefore, whatever may now appear at the ſurface of the ground in a country over-blown with ſand, it is probable that there may be a bed of hard granite below the ſand or ſoil of the iſthmus of Suez, which prevented the heavy tides that paſſed over from the Red Sea to the Mediterranean, from plowing up a deep channel quite through the iſthmus, between thoſe two ſeas. I have taken particular notice of every narrow neck of land which I have ſeen between two ſeas, or between two bays; and I every where found that they conſiſted of very hard and ſtrong rock; and I am confident, that every narrow iſthmus in the world conſiſts of very hard rock.

In ſhort, there is no part of the ſurface of the earth that does not bear clear and indelible marks of the high diluvian tides in all the ſtages of the deluge.

The higheſt mountains of the globe generally conſiſts of rough granite rocks. Theſe were formed during the higheſt ſtate of the chaotic tides. The higheſt mountains are found within the tropicks or under them, but not immediately in the run or current of the tides near the equator; which ſuggeſts to us, that the main current of thoſe tides was too ſtrong, rapid, and conſtant, for the ſubſidence of ſuch quantities of matter in a ſhort ſpace of time, as is required to the formation of ranges of high mountains, which would be formed nearer the tropicks, where there would be ſome eddies, and where the tides would not always ruſh forward with ſuch force and violence. We obſerved before, that all the ranges of mountains between the tropicks trend from north to ſouth, but the line of the mountains without the tropicks, upon both ſides of the equator, falls a little back to the eaſtward; ſo that in Britain, and in parallel northern latitudes, the longeſt ranges of mountains trend from about S. S. W. to N. N. E. and they will fall back to the eaſt proportionally in equal ſouthern latitudes.

The elevated plains of Abyſſinia, and the Mountains of the Moon, and others, in the interior parts of Africa, ſtretch in a continued range with very little interruption all the way ſouth to the Cape of Good Hope. This great range trends due ſouth, from about the fifteenth degree of north latitude to Monomotapa, when it inclines a little to the eaſt, until it reaches the neighbourhood of the Cape, in about the thirtieth degree of ſouth latitude.

The northern great range of mountains and high lands of the Old Continent, commence ſomewhere about the latitude ten or fifteen north, and it ſtretches away due north through the Mogul Empire, and through Buckaria, until it joins the elevated plains of Independent Tartary, where they begin to lean a little towards the north-eaſt; but in general, they ſtill ſtretch away northward, with very little interruption, until it terminates in the extremity of the north. This is ſtill a longer and more extenſive range than that which trends away ſouth through Africa. The great range of the Aſiatic mountains is not only of immenſe length from ſouth to north, but it is alſo of great breadth from eaſt to weſt, though with conſiderable interruptions, which in fact divides them into ſeveral ranges. The European great range of the Alpine mountains ſtretch away north from Monaco, upon the eaſt ſide of the gulph of Genoa, through Savoy, Switzerland and Germany, and with ſome little interruption, continue a northern courſe to the extremity of Lapland; but with an inclination to the eaſt of north. The principal range of mountains in the iſland of Britain, keep the ſame general courſe from north to ſouth, with a lean towards the north-eaſt. This range commences in Caithneſs,

neſs, in the northern latitude of fifty-eight, and it ſtretches ſouthward through the countries of Sutherland, Roſs, Inverneſs and Argyle, and this weſtern diviſion of the range ſeems to terminate in the iſland of Arran.

The eaſtern column or diviſion of this greateſt range of Britiſh mountains, commences in Banff or Aberdeen-ſhire, in the north latitude, about fifty-eight, and in about one degree of weſt longitude from London, and ſtretches ſouthward through the counties of Aberdeen, Angus, Perth, Stirling, Dunbarton, Renfrew, Ayr, Galloway, Cumberland, Weſtmoreland, Lancaſter, Flint, Denbigh, Merioneth, Montgomery, Cardigan, and it terminates in Pembroke-ſhire in South Wales, in the north latitude about fifty-one, and in about five degrees of longitude weſt of London. The interruptions in this range are not great.

The American ranges of mountains likewiſe trend from ſouth to north. The higheſt mountains upon the face of the globe are thoſe of South America, and among theſe the Cordileras are diſtinguiſhable, for their vaſt height, magnitude, and extent.

The principal range of the mountains of South America commence in the mountains of St Martha, in about the tenth degree of north latitude. The mountains of St Martha join the elevated plains of New Granada, and ſtretch away due ſouth in a lofty magnificent ridge, parallel to the weſt coaſt, all the way to Patagonia, and with very little interruption to Cape Horn, in about fifty-five degrees of ſouth latitude. This is a very long, high and regular range of mountains, ſtretching from north to ſouth, with a little inclination to the eaſt, as they advance ſouth through Chili and the Terra Magellanica. The mountains of North America, though more extenſive, are not ſo regular and lofty as thoſe of the ſouth; and therefore the ranges cannot be ſo diſtinctly traced out. The Apalachian mountains, which commence about the 30th degree of north latitude, trend away northward through Canada and Labrador, and perhaps through Greenland, with the interruptions of Hudſon's and Davis's Streights. This is a conſiderable range of mountains; but I ſuppoſe that the moſt conſiderable and extenſive range in North America, are thoſe which ſtretch along the weſt ſide of the continent, not far from the weſt coaſt, from about the twentieth degree of latitude to the extremities of the north, and north-eaſt, where America joins the continent of Aſia, an extent of more than four thouſand miles.

Many philoſophers and naturaliſts aſſert, as an eſtabliſhed fact, that all ranges of mountains run from eaſt to weſt; but this aſſertion is founded upon very limited and imperfect views of the ſubject. I grant, that from a curſory and partial view of the mountains of all countries, they do appear at firſt ſight as if ranged from eaſt to weſt; but this is a haſty concluſion from a curſory view, without inveſtigating the ſubject. The running of the high tides from eaſt to weſt, over the ranges of mountains, have plowed and ſcooped out the glens, the channels and valleys in that direction; and by that means diſſevered the mountains from one another, into ridges of different lengths, running from eaſt to weſt; but this is only the marks and effects of the diluvian tides, running at firſt over thoſe high lands, when they were elevated plains; the prodigious weight and force of which tides plowed up and tore thoſe plains to pieces, waſhed away the earthy matter out of the glens and excavations, and left them as we find them in the form of mountains and glens, rocks and precipices, of which there is an almoſt infinite variety. But that the mountains in general really are ranged from north to ſouth, I have produced ſufficient inſtances to prove the fact to a demonſtration.

When the high tides of the great South Sea would fall into the Atlantic ocean, through that wide and ample entrance between Cape St Roch, on the coaſt of Brazil, and Cape Palmas, on the coaſt of Guinea, after moſt of the dry land of both continents were formed, thoſe high and weighty tides would ruſh powerfully againſt all the ſhores of the Atlantic.

The Atlantic ocean is really a gulph of vaſt magnitude and extent; round the north end of which, there are a number of ſubordinate gulphs. The ſea between Cape Palmas and Cape St Roch, is the only entrance in and out of this gulph, either for the tide or for ſhips. There will be a great tide in the Atlantic itſelf, independent of the South Sea; however, theſe tides muſt be inconſiderable, when compared with thoſe of the great Pacific Ocean.

The great height of the mountains of Peru, is perhaps the beſt means or helps that we have to aſſiſt our ideas in forming proper and adequate conceptions of the prodigious height of the diluvian chaotic tides, before the ſurface of the poſtdiluvian earth was formed. The Cordilleras in Peru are ſaid to be four or five miles of perpendicular height above the level of the ſea. This may be called, and it really is a great height above the common ſurface of the earth and ſea; however, I ſuppoſe, that this height is but ſmall in compariſon of the firſt diluvian tides. I have before hinted at the natural cauſes of the prodigious height of thoſe tides. The great height of the diluvian tides would diminiſh gradually in the courſe of time, in proportion as dry land was formed. I obſerved and explained before, that the ocean actually purged itſelf by the tides, of the looſe earthy matter, in proportion as more dry land was formed, which tended to ſink the bed of the ocean, and gradually to ſink the tides. If we ſuppoſe, that the firſt great diluvian tides were eight or ten miles high, before the mountains and elevated plains of the earth were formed; we may ſuppoſe, that tides of near half a mile in height, would fall into the Atlantic gulph from the great Pacific Ocean, for a conſiderable time after moſt part of both the continents were formed. Theſe high and weighty tides would fall with prodigious force upon all the ſhores of the Atlantic, and its ſubordinate bays and gulphs; and in fact, we ſee evidently, that the tides of the Atlantic have made terrible havock upon the ſhores both of the Old and New Continents.

The courſe of theſe high tides from the Pacific Ocean into the Atlantic, would run nearly from ſouth to north. When theſe tides were advanced as far forward between the two continents as the latitudes forty, fifty and ſixty north, they would then fall with great weight and force upon the eaſtern coaſts of North America, and we there ſee very evident marks of their great effects in the many iſlands, ſounds, gulphs and inlets, which are found upon the eaſtern coaſt of America. Theſe tides ſeem to have fallen particularly heavy upon thoſe coaſts to the north of the latitude forty, as may be ſeen by Hudſon's and Baffin's bays, and the many other deep bays and gulphs upon that coaſt; and it is highly probable, that theſe tides found ſome low lands, and paſſed at firſt over the northern parts of America, as well as over the iſthmus of Darien.

When theſe Atlantic tides were advanced forward to the above-mentioned latitudes, they would not only preſs hard upon North America to force a paſſage over or through that continent, but they would alſo puſh forward in a direct line from the mouth of the great Atlantic Gulph, which is under the equator, and fall with exceſſive weight upon the northern coaſts of Europe; and there we ſee great and evident marks of their prodigious effects and ravages in the indentings of the northern coaſts; and they have made powerful efforts there, to force a paſſage quite through between the Old and New Continents, which, however, was not completed. Theſe tides might paſs over ſome low valleys to the north and eaſt, as they did over Suez and Darien; but they did not complete a paſſage quite through ſo low as the preſent level of the ſea, which is now made perfectly evident by the reſearches and diſcoveries of the celebrated Captain Cook.

The high tides of the Atlantic, when advanced as far north as our latitudes, when near high water,

ter, would fall back to the eaſtward, and ruſh down with force and violence upon the weſtern coaſts of the Britiſh iſlands, the coaſts of Norway, and other parts of the continent of Europe.

We have now brought our obſervations nearer home, where circumſtances can be ſeen and inveſtigated by every inquiſitive man who is ſearching after truth. The ravages of the ſea upon the weſtern iſles,—the indentings of the weſt coaſts of Britain, Ireland, and Norway,—and the bays, ſounds, channels, and inlets of the weſtern and ſouthern coaſts of Europe, are clear and convincing proofs that a great weight and force of water has operated powerfully and effectually upon thoſe coaſts. It was then that the Britiſh Channel was cut through between France and England by a ſtrong and weighty run of the high tides from the Atlantic into the German Ocean. It was then that the weſtern iſlands were diſſevered from the main land, and from one another, and the various ſounds and channels were formed; and it is very probable that it was then that the Baltic Sea, with all its gulphs and indentings, was ſcooped out of the low lands of the northern parts of Europe. Let any man who impartially ſearches after truth, examine the map of the weſt coaſts of the Britiſh iſlands, &c. and then let him reflect upon what he has ſeen of thoſe coaſts; and he muſt of neceſſity be convinced, that high, weighty, and forcible tides have made powerful efforts to work out numerous paſſages through every diſtrict of thoſe coaſts; and in many places their efforts have been effectual in diſſevering one iſland from another, and forming the ſounds between them, in ſcooping numerous deep bays and gulphs out of the boſom of the land; and in ſeveral places a narrow low bar of hard rock was interpoſed to prevent thoſe tides from cutting quite through, and joining two bays or inlets in one ſound or channel. Numbers of theſe narrow necks of land are to be found in all parts of the world.

Before I diſmiſs theſe ſpeculations upon the outlines of the ſuperficies of our globe, I will beg leave to remark, that I perceive ſome phenomena and ſome facts which I cannot account for.

Moſt of the dry land of our globe is ſituated to the north, and the loweſt parts through the middle of each continent, at the iſthmus of Suez and of Darien, which appear to have been the principal currents of the high equatorial tides, are conſiderably to the north of the equator; but I cannot perceive the natural cauſe why it ſhould be ſo.

It is acknowledged by all intelligent men, that the Old Continent is much bigger than the new. Some ſay that it is more than twice as big; however, the late diſcoveries of Captain Cook upon the weſt coaſt of America, make it evident, that the northern parts of the New Continent are much larger than was formerly ſuppoſed. But what may really be the different comparative extent of each continent, I cannot determine. However, it appears, that of the Old Continent, all Aſia and Europe, and more than one half of Africa, is ſituated upon the north ſide of the equator, and of what properly belongs by ſituation to the old part of the known world, nothing but the leſſer half of Africa, with New Holland and ſome leſſer iſlands, has been yet diſcovered to the ſouth of the equinoctial line; and I am perſuaded that there is not much more to be diſcovered. Matters are not much different in America, with reſpect to the diſpoſition and ſituation of the dry land. America is conſiderably longer from north to ſouth than the Old Continent.

The ſouth end of Patagonia, which is the ſouthern extremity of the continent of America, is laid down by Geographers about twenty-five degrees farther ſouth than the Cape of Good Hope, which is the ſouth point of Africa, and the great iſland of Terra del Fuego is ſtill farther ſouth than Patagonia. But although America is much longer from north to ſouth than the Old Continent, it falls very much ſhort of the breadth of the old from eaſt to weſt. But whatever may be the different proportions of the extent of the ſurface of both continents, it appears that there is more of the New Continent ſituated to the ſouth of the line than there is of the old. But although there is ſuch a ſmall proportion of dry land in the ſouthern hemiſphere, the higheſt mountains in the world are found upon the ſouth ſide of the line. The Cordilleras in South America are by far the higheſt mountains in the world; and I ſuppoſe, that they are the moſt magnificent connected ridge of mountains any where to be found. The elevated plains in the middle of Africa are of great height, but very little known, as are moſtly all the interior parts of that quarter of the globe. The Mountains of the Moon and of Monomotapa, to the ſouth of the line, are erected upon theſe high countries, like ſo many lofty towers built upon an eminence, which muſt raiſe them a prodigious height above the level of the ſea.

This chain of mountains is of great extent from north to ſouth, ſtretching from the line into the ſouthern parts of Caffraria; and it is highly probable, that the end of this chain, which is ſituated next the equator, are the higheſt of any mountains in the Old Continent.

It is well known to naturaliſts, that fluid bodies, eſpecially water, are attracted and put in motion by the influences of the Sun and Moon, which undoubtedly is the cauſe of the tides of the ocean. This being well known, it muſt of conſequence be granted; that the greater the extent and depth of water expoſed to the heavenly influences, the greater will be their effects, and the higher the tides will be raiſed.

From this conſideration, we are led to conjecture, that in the height of the chaotic ſtate of the deluge, there was leſs earthy matter mixed in the ocean to the ſouth than to the north of the equator; and conſequently, the tides would be raiſed higheſt upon the ſouth ſide, which is the cauſe of the higheſt mountains being found in the ſouthern hemiſphere. But why there ſhould be more earthy matter upon the north than upon the ſouth of the line, we have no foundation ſo much as for a conjecture.

All the external phenomena of mountains are eaſily accounted for, from the conſideration of the direction and forcible currents of the tides, which flowed over the land during the formation of the ſtrata. It was then by thoſe high and forcible tides, that the long channels were cut through the mountains from eaſt to weſt; through which channels, ſtrong and weighty currents ran from ſea to ſea, many of which are now dry land far from any tide:—it was then that the concavities and gulphs among the mountains were ſcooped out by the violent whirling motion of the waters in all directions, which now give the excavations of the mountains ſuch various deep and gloomy forms:—it was then that precipices were formed and rocks undermined, by a ſtrong and weighty current running forcibly under the ſide of a mountain, and waſhing away the one ſide of it, before induration was compleated, or even far advanced:—it was then that ſingle, and ſingular rocks of antic and groteſque figures were formed, by the tides waſhing away their baſis, and retreating before the whole fabric was demoliſhed. All countries produce inſtances of theſe ſingular antic rocks, but ſome of them are more remarkable and extraordinary than others. Many of theſe are quite undermined, and project their horrid fronts, and threaten to overwhelm all who approach them. In ſhort, the marks of water are every where viſible, and eaſy to be diſcerned among the mountains and rocky ſhores of the ocean. But all theſe gulphs, bays and inlets, which ſeem to disfigure the face of the earth, are not however to be conſidered merely as blemiſhes of nature. In truth, they are great and neceſſary perfections, highly conducive to the good of the world. A commercial ſtate of the world, by which the mutual wants and conveniencies of all are reciprocally received and returned, is undoubtedly the moſt happy and perfect ſtate of ſociety, and the ingulphed ſituation of the numerous Mediterranean ſeas, and the “ nook-ſhotten” figure of the earth is undoubtedly the moſt convenient for commerce, as, by this diſpoſition of things, the commercial ſhips ſail into the heart of the continents, and carry in and out goods, which could not be carried thouſands of miles by land.

Let us take a curſory view of the face of the globe, and conſider the diſpoſition of things in a ſocial and commercial light. There are but two great ſeas in the world, viz. the Pacific and the Atlantic oceans; and it may be obſerved of theſe, that the firſt is ſituated upon and all round the outſide, and the other within the boſom and center of the dry land; ſo that by navigating the Pacific ocean, we can go round about and viſit all the outer boundaries of our inheritance, the earth, and by navigating the Atlantic, we can penetrate into the boſom and center of the earth in a thouſand places. The courſe and progreſs of commerce has always been from eaſt to weſt, and from the center towards the circumference. Commerce began in Aſia, but its chief ſeat at preſent is in Europe; and Europe is the beſt ſituation in the whole world for commerce, when taken in an extenſive view. The courſe of foreign commerce is to go out of the Atlantic or great commercial gulph, into the Pacific, which is the great commercial ocean; and in this route we muſt paſs between Brazil and Guinea, and forward to the left by the Cape of Good Hope, or to the right by Cape Horn. In purſuing the left hand tract, we come to the fertile, rich, and extenſive countries and iſlands of Aſia, where we exchange our own commodities for the rich fruits, the rich ſpiceries, and the rich ſtuffs of the eaſt, which muſt come home by the ſame route. The weſtern coaſts of the beſt part of America being in the hands of the Vandalic Spaniards, perhaps originally Tartars, who improve nothing, there is as yet but little to excite general commerce to paſs through the Streights of Magellan, or to double Cape Horn.

When we come again into the Atlantic, which may be called our greater Mediterranean, and glance at the diſpoſition of things, for the convenience and advantage of commerce, what benevolent heart will not overflow with gratitude and admiration of the ſupreme wiſdom and beneficence, in diſpoſing all things for the general good! It is here that we clearly perceive the wiſe and benevolent deſigns of the Creator, in controlling and directing the very rage of the elements for the good of the univerſe, or in other words, for commercial convenience; which is the means of the greateſt proſperity the world is capable of.

The rage of ſtormy winds exciting the violent motion and force of the diluvian tides to tenfold fury, which has tore out the very bowels of the land in a thouſand places, into gulphs, ſounds, and Mediterraneans, and endeavoured to ſweep away the whole face of the dry land, and mingle it again with the waters into another chaos. " But all things ſhall work together for good,"—for this fury and ravage of the elements has formed our great navigable canals for commerce, which (O happy Britain!) diverge every way from thy fortunate iſland, like radii from a common center; and thy ſhips are continually failing to the weſt and to the eaſt, to the north and to the ſouth, upon theſe commercial canals, which are ready prepared for thee by the univerſal Patriot and Founder of happy ſituations, and of happy ſtates.

The Britiſh iſlands, though far north, are ſituated in the center of the univerſe in reſpect to commerce. The Britiſh merchant carries out by the Cape of Good Hope the produce of our iſland, improved by the labour and ſkill of our artificers, in exchange for which he brings home rich merchandize from afar. He fails weſtward with abundance of our produce and of our commodities, and brings home the rich and comfortable productions of the new world.

To the ſouth-eaſt, he traverſes the great length and many windings of the Mediterranean, to diſpoſe of the manufactures of his country, and to bring home many of the comforts of life.

To the north-eaſt, he goes to Archangel for timber, and up the Baltic with ſome few of our commodities, for timber, hemp and iron, the laſt of which might be made at home, to ſupply ourſelves and others. To the north and north-weſt of Europe, the Britiſh merchant carries out but little, yet he makes profitable voyages. He finds the extenſive northern gulphs repleniſhed with whales and other valuable fiſh, by which himſelf and his nation are enriched. The Britiſh merchant goes to the inhoſpitable ſhores of Hudſon's Bay, and many other cold and barren regions, and brings home the fine furs of the north for the comfort of our fine ladies, and lady-like gentlemen.

Thus, the high diluvian tides, and the rage of the elements, have torn and interſected the bowels of the continents and iſlands, for the general ggod of man in a ſocial and commercial ſtate.

The Atlantic ocean is a great baſon formed in the center of the habitable world; from which great baſon, a great number of canals and channels are cut out every way, to water and enrich all countries, with plentiful exhalations diſſolved in rain, and with the reciprocal benefits of commerce. Two of theſe are eminently diſtinguiſhable above the reſt, for extent and general utility, viz. the gulph of Mexico, with all its ſubordinate gulphs and bays, in the New Continent;

tinent; and the Mediterranean, with the Black Sea, the Gulph of Venice, and all its other gulphs and bays, in the Old Continent; and theſe two great branches of the Atlantic have nearly cut through both the continents.

Would it not be a great convenience and advantage to the commercial world, if theſe two narrow bars were cut through by the art of man?

It is ſaid, that Alexander of Macedon meant to cut through the iſthmus of Suez, for the reciprocal convenience of the commerce of India and the Mediterranean. Would it not be a great convenience to the world, and a general advantage to the commerce of Europe, if the iſthmus of Suez and of Darien were cut through, to make a ready communication from ſea to ſea in both places? I grant, that ſuch a ready communication would be an immenſe advantage to the commerce of Europe, and of all nations; but what is generally underſtood by a navigable cut is abſolutely impracticable; a navigable canal with locks is practicable, but how far convenient circumſtances may concur to favour the execution of ſuch a work, as a navigable canal over either of theſe two places, I do not know. It is a pity that the iſthmus of Suez has ſo long been and ſtill is under the dominion of thoſe barbarians the Turks, a ſpecies of Tartars or hereditary

tary barbarians, who will do nothing for the good of the world, or for the general benefit of ſociety and commerce. Was the iſthmus of Suez in the hands of a wiſe and intelligent power, I ſhould imagine that a canal with lochs, upon a ſufficient ſcale to carry through ſhips of all burdens, would be ſoon executed, and the ſhips of all nations paſſing through and paying a moderate toll, would ſoon reimburſe the expence, and produce a valuable revenue to the State; but ſuch are the mutual jealouſies of the power and proſperity of all nations, that there is little room to hope for ſuch a public benefit.

The commercial part of the world in general, are not ſo much intereſted in the iſthmus of Darien as in that of Suez. However, a navigable canal over Darien would be a great convenience to the countries of Peru and Chili, and likewiſe to California, and all the weſt coaſt of North America, between California and the bay of Panama. But while all theſe coaſts lie under the dominion of their preſent oppreſſors, there is not much hope that thoſe naturally glorious and fertile countries will ever be favoured with ſuch a ſpring and impulſe to induſtry and commerce, while the Spaniards are the inactive, but cruel lords of ſuch fine and improvable regions of the earth.

We obſerved above, that the amazing weight and force of high tides, even after the higher grounds were formed, made numerous deep and wide runs and channels through the chains of mountains and higher grounds, before induration was compleated, examples of which may be found in Britain.

Such, for inſtance, is that betwixt Fort-william and Invernefs,—between the Frith of Clyde and the Frith of Forth,—between the Solway Frith and the North Sea, to the eaſt and ſouth of Berwick upon Tweed,—between Parkgate and ſeveral parts in the north-eaſt of England, and between the Severn Sea at Briſtol and London; and it highly deſerves to be remarked, that ſeveral of the wideſt of theſe channels were afterwards filled up to a certain height with the ſtrata of coal and coal metals. Each of the natural channels or runs of the tides juſt mentioned, excepting that between Invernefs and Fort-william, are really filled up with coals and the concomitants of coal. The truth of this obſervation is obvious, and will bear every enquiry; but I will not enlarge upon it; only allow me to remark, that the wiſdom and provident goodneſs of Almighty God ſhines conſpicuouſly in this diſpoſition. The rich and pleaſant valleys, and low plains near the ſeas and large rivers, were to be the habitations of the ſocial, commercial, buſy world of mankind; and there the coals are found, perfectly convenient for home conſumption, and for ſupplying the wants of others, by the great commercial high-roads, the waters. Had the coals been depoſited in the bowels of the higheſt mountains, they would in a great meaſure have been uſeleſs to ſociety, manufactures and commerce. We could not have carried the coals from the diſtant mountains, nor lived near them. The high mountains are too barren, too cold, and too far from the ſeas, for the reſidence of man in a ſocial commercial ſtate, but there is none or very little of them there. I have neither ſeen nor heard of coals being found any where in very high mountains; however, I do not aſſert the contrary; ſuch a thing may exiſt in ſome part of the world or other, though I am of opinion, that there is no ſuch thing as real and regular ſtrata of coal in high mountains. None have yet been diſcovered in ſuch ſituations; and therefore, we may aſſert, that the thing is not common. In the common courſe of things, matters are better ordered for our convenience. We generally find the coals in low valleys, and in eaſy riſing grounds or low hills, in ſituations where the dwellings of men and their manufactures are pitched, and ſeldom very far from the ſeas or navigable rivers. He who formed the earth knew all his works from the beginning, and what uſe every part of it was to be turned to in every age of the world; and therefore, every part was fitted for the ſcenes to be acted upon that particular ſtage.

Great Britain could never have been ſuch a manufacturing commercial country as it is, had it not produced ſuch abundance and variety of metals to be manufactured, and ſuch abundance of excellent coals as are found and worked, with which our metals are manufactured. The precious and uſeful metals are frequently diſcovered in pretty high mountains and remote ſituations; but their great value in proportion to their bulk, enables us to work them, and to carry them to the manufacturing and commercial parts of the country. Coals, on the contrary, muſt be a cheap commodity in proportion to its bulk, otherwiſe it would never anſwer for the furnace, the forge, nor the kitchen. As a vaſt bulk and conſiderable weight of coals is uſed for all common purpoſes, the price would become too high before they could be brought down from the mountains to the cities and habitable valleys.

The more I look into the Mineral Kingdom, the more clearly I diſcern the wiſdom and providence of our beneficent Creator! Many wiſe and worthy philoſophers have given us numberleſs clear and convincing proofs of conſummate wiſdom, benevolence, and deſign, in fitting all animals and plants for their reſpective purpoſes, ſituations, and manner of living. Many excellent obſervations have been made upon all parts of the animal and vegetable kingdoms; and I am perſuaded, that in time, there will be as much ſaid upon uſeful ſubjects relating to the Mineral Kingdom, and as much to the purpoſe. I know well that there is as much to be ſaid. The moſt neceſſary articles, to ſupply the wants and to ſuit the conveniencies of man, from the Mineral Kingdom, are found in the greateſt plenty, and are the eaſieſt to be procured: Witneſs pit-coal, iron, building-ſtone, limeſtone; but I will not deſcend to particulars. The field is too extenſive for me. In time it will be cultivated. It will be thoroughly known and acknowledged in the courſe of time, that there are as clear footſteps of a wiſe and benevolent Creator diſcoverable in all parts of the Mineral Kingdom, as are diſcovered in the animal and vegetable; and I reckon all the characters and circumſtances relating to coal and ironſtone, which was the ſubject of our enquiries above, to be eminent inſtances of benevolent wiſdom and deſign. When future naturaliſts ſhall lay the foundation of their reſearches in the Mineral Kingdom upon true and rational principles, and ſhall diſcover clear demonſtrations of the wiſdom and deſigns of providence in the formation of the ſurface of our globe, and in the reſpective diſpoſition of all foſſil and mineral bodies, they will not then be offended at the leading, though rude obſervations of a ruſtic philoſopher.

They will rather thank him for the trouble he has been at in clearing the ground, and laying this rude foundation for their future profit and pleaſure in mineral ſtudies.

I will now offer a few obſervations concerning the mutations of our globe. In the two laſt general heads, I pointed out and explained ſeveral clear and inconteſtible proofs of an univerſal deluge. The obſervations I mean to advance at preſent, derive their force and importance in a great meaſure from their connection with, and relation to my former obſervations, in proof and illuſtration of the doctrine of the deluge.

My remarks upon the fragments of quartz, ſhirl, and mica, &c. will in time appear to the candid and intelligent, to be deciſive proofs that they are fragments of ſome original ſtrata, which ſtrata we can no where find; nor can we give any account or rational conjecture about them, without allowing of what was univerſally believed by all antiquity, and celebrated by many of the moſt ancient poets and philoſophers of many nations. I mean the primæval ſtate of the earth before the deluge.

I reckon it a certain fact, that the quartz, ſhirl, and mica, with all the fine grains found in the compoſition, and in the decompoſition of our rocks and ſtrata, which are not of a priſmatical figure, are fragments and remains of the antediluvian ſtrata; and I think it probable, that all our metallic and mineral ores were diſpoſed in ſtrata in the antediluvian ſtate of the earth. I think it probable, that the metals were all originally in a pure and malleable ſtate; and that the ſtrata of original metals, as well as all others, were broken to pieces, and mixed with the waters in the chaotic ſtate of the terraqueous globe; and that by the motions of the tides, they were all ground down to ſmall grains and particles, which were afterwards mineralized, or mingled with heterogeneous mineral matter, before theſe compounds were depoſited in our mineral veins, and in the compoſition of ſome of our ſtrata.

A great deal might be ſaid about the origin of the antediluvian ſtrata; but as it muſt all be hypothetical, I will not dive into ſuch uncertain and uſeleſs conjectures. But notwithſtanding this reſolution, I would not have it underſtood that I give up the point as uncertain. I have made it abundantly evident, that ſuch ſtrata certainly did exiſt. I hinted before, that the various fine grains and fragments which are found in the compoſition of our ſtrata, have all the appearance and characters of originality. The atoms or particles which compoſe the finely laminated textures of the maſſes of talc, muſt be inconceivably ſmall.

We can divide the plates or laminæ of talc into an inconceivable degree of fineneſs. What ſort of particles then muſt ſuch bodies be compoſed of? and the other grains ſeem to be equally fine. If we ſhould decompoſe any of theſe bodies, and look for the original particles which compoſe and make up the maſs, I ſuppoſe we ſhould not be able to diſcover them. We ſhould find them evaneſcent; but our ſtrata are not ſo. If any of our ſtrata are decompoſed, we can diſcover and give an account of the component parts, which are quartz, ſhirl, mica, and various other fine and pure grains; but if we look for the atoms which make up theſe fine grains, we ſhall find them evaneſcent in our hands.

The inconceivable fineneſs, and homogeneous purity of the whole maſs of theſe original fragments, ſuggeſts to me one remark, which I beg leave to offer, viz. As there are no perceptible grains or particles in theſe fine fragments, it is evident to me, and will appear evident to every candid enquirer into theſe matters, that our globe has ſuffered only one great change by water, or otherwiſe. Theſe original fragments do not point out to us any thing whatſoever that might ſuggeſt the idea of ſeveral deluges, or of the earth having ſuffered ſeveral great mutations by any means whatever. The component parts of our rocks and ſtrata, clearly point out to us the neceſſity of acknowledging that our globe has ſuffered one great change by water; but the phenomena of nature go no further. We are obliged to acknowledge, whether we are willing or not, that this one change was accompliſhed by the agency of water; for it is now very generally known, that the marks of water are conſpicuous all over the ſuperficies of the globe. The fineneſs and purity of the eſſence and quality of theſe original fragments, not only ſuggeſt to us, that the earth has ſuffered but one change, but they alſo point out to us an ocular demonſtration of a revealed truth, viz. that the Almighty in the beginning created all things out of nothing. Moſes ſpeaks of "all things which 'the Lord God created and made;" and there appears to me a notable diſtinction between the word *created* and the word *made*. The idea we have of the meaning of the word *create*, is to bring ſomething into exiſtence which had no being before; but our idea of the word *make*, or *made*, is the exerciſe or effects of a mechanical operation, whereby ſomething is formed of pre-exiſting materials, agreeable to the deſign and ſkill of the maker.

When the great philoſopher Moſes ſays, that the Lord God created the heavens and the earth, and all the hoſts of them, the word *create* ſeems to me to point at the act of the almighty will and power in the firſt production of matter; and the word *made* ſeems to point at the proper uſe of matter in the formation of worlds, animals, vegetables. But theſe are depths not to be ſounded by me, and therefore I will only touch them lightly; however, I cannot help thinking that the fineneſs and homogeniety of the original particles of matter juſtifies my ſaying ſo much.

Again, we are told by Moſes, that in the beginning of the creation, or of making the earth, and while it was yet without form, "The Spirit "of God moved upon the face of the waters." Perhaps we may here underſtand by *Spirit*, wind, or air in motion, as an agent, which ſuggeſts to us, not only the idea that the antediluvian earth was formed by the agency of water in motion, but alſo, that this agent operated in a ſmooth and orderly manner. The atoms which compoſed the ancient ſtrata were inconceiveably fine, and they were as finely put together, as plainly appears by the fragments of them which we ſee, which exhibit the moſt perfect ſtratification; and we may obſerve, that fine materials are capable of being finely fabricated; and they deſerve it. But I will return to the examination of the component parts of our ſtrata, where I can walk upon more ſure ground, than in diſquiſitions about the ancient ſtrata. It appears to me highly probable, that our metallic ores were all in a pure and malleable ſtate, and diſpoſed in regular ſtrata in the antediluvian earth; and that theſe ſtrata, as well as others, were broken and ground to pieces in the violent motion of the waters of the deluge; and that they were mineralized, or mingled with heterogeneous particles before they were lodged in our veins, and in the compoſition of ſome of our ſtrata.

That a conſiderable quantity of mineral and metallic ore is blended in the compoſition of ſome of our ſtrata, is evident. I have frequently ſeen it, and what I have ſeen, no doubt but many others have ſeen alſo.

Gold is chiefly found in grains of various ſizes, mixed in the compoſition of many rocks, though not in a mineralized, but in a pure and virgin ſtate.

Irom is commonly found in the compoſition of a great number of rocks. I have ſeen lead blended in the compoſition of the ſtrata in many places. For inſtance, there is a ſtupendous rock at Cumſumlog in Cardiganſhire, Wales, which, to a great extent, is mingled with grains and flowers of fine blue lead ore, where I ſaw a great number of miners ſcattered upon the high front of the rock, moſt of them ſuſpended by ropes, blowing down the rock with gunpowder, in order to ſeparate the lead from it. I have frequently ſeen copper in the body and compoſition of the ſtrata in many places. The tin grains in Cornwall, found in the compoſition of a ſpecies of granite, is another inſtance; and theſe few are ſufficient to prove the fact.

If there was no pure virgin metal found in the world, my ſuppoſition of the ancient ſtate of the metals would be more doubtful; but as there is a good deal found in that ſtate in many parts of the world, this circumſtance favours my opinion; and moreover, it is a remarkable fact, which is worthy of attention, that the quantity of pure virgin metal found in a malleable ſtate, is in exact proportion to its toughneſs and ductility.

1. Gold is found in ſmall maſſes, and in grains of various ſizes, but always in its virgin malleable ſtate, embodied and blended in the compoſition of the rocks, and mingled in the ſands of rivers and rivulets, from the decompoſition of thoſe rocks. I hinted before, that there being ſome virgin metals found in the preſent earth, countenances the ſuppoſition, that they were all pure and malleable in the antediluvian earth; and I will now add, that the manner in which they are found corroborates my opinion.

Virgin metals are moſt commonly found either in ſmall grains, blended as part of the compoſition of the ſtrata, or elſe imbedded in ſtones, or in cliffs of rocks, and often ſqueezed by the preſſure of the ſurrounding rocks, ſo as to give the larger maſſes a rough, unequal ſurface, being the exact impreſſion of the bed they were found in. This figure is given by forcing the pliant metal into all the irregularities of the rock, like a print of butter. But grains and ſmall maſſes blended in the compoſition of the ſtrata, is the moſt common ſtate of the virgin metals.

2. There is more ſilver found in a pure and malleable ſtate, than of any other metal, excepting gold. I ſuppoſe that the tough and ductile property of gold is the natural reaſon of its not being broken ſmaller by the attrition of the fragments of rocks in the agitation of the chaotic ſtate of the deluge; and it is remarkable, that ſilver is next to gold for toughneſs and ductility, and accordingly, the proportion of each found in a pure virgin ſtate, correſponds exactly with theſe properties. In ſome of the ſilver mines of Mexico and Peru, the ſilver is found pure in the maſſes of ore. By viewing ſamples which I have ſeen from thence, the ſilver appears rather blended in large grains, and ſmall fragments of virgin ſilver, with other mineral ſubſtances in the general maſs of the ore, than mineralized like our blue ores, which are rich in ſilver. In the American ores we can ſee large grains of ſilver with the naked eye; and as an unqueſtionable proof that we are not deceived, we can cut them with a knife;

whereas, in our mineralized ores, which are rich in ſilver, the particles are ſo ſmall, and ſo perfectly blended and mineralized, that we cannot diſtinguiſh them even with the help of glaſſes.

3. Copper is more tough and ductile than lead, and leſs ſo than ſilver; and accordingly we find more pure malleable copper, than of lead, and leſs than of ſilver.

Whether the learned naturaliſt will agree with my opinion concerning the ancient ſtate of the metals or not, he muſt acknowledge, that this ſeries and gradation which I have pointed out countenances my opinion. There muſt be ſome reaſon for this gradation, and I think he cannot point out one that correſponds ſo well with the phenomena of the compoſition of the ſtrata; and therefore, I really think that I might have ranked the metals with the quartz, ſhirl, and mica, as being equally evident fragments of original ſtrata.

I ſuppoſe that this hint is new, as well as many others in theſe papers; and therefore, no doubt but they will ſtartle ſuch naturaliſts at firſt, as have not been accuſtomed to view theſe ſubjects in the ſame light with me; however, I hope it will be acknowledged, that my obſervations are founded in nature, and I declare that it was not the affectation of novelty, but the love of truth, that prompted me to communicate them to the public. The phenomena of nature have pointed out to me ſuch obſervations as may have an air of novelty. I ſubmit them to the examination of the candid naturaliſt, and when he has thoroughly and impartially examined my works, he will acknowledge that truth is on my ſide.

Naturaliſts have been greatly puzzled to find a quantity of water ſufficient to cover all the earth, to the depth of about forty feet above the ſummits of the higheſt mountains, ſo as to produce an univerſal deluge, as deſcribed by Moſes, and I confeſs it is a puzzling ſubject. It is ſtill as difficult as ever, to find a quantity of water ſufficient to make ſuch a deluge as the moſt of them have contended for. Some of them have laboured hard in ſearch of it, and they have ranſacked Heaven above, and the loweſt parts of the earth, to collect ſuch a quantity upon the face of the globe as would deluge the higheſt mountains; but their reſearches have not been effectual; and their account of this matter is by no means ſatisfactory, nor can I give them any aſſiſtance. I do not know where to find a ſufficient quantity to cover the whole face of the globe to the height of the loweſt mountains; if we allow thoſe mountains to remain firm and ſtable as they now are.

It is out of nature, and appears to me impoſſible without a miracle. But if we ſuppoſe, that the original ſtrata of the antediluvian earth were ſome how or other diſlocated, broken to pieces, and mixed with the waters of the ocean in a chaotic ſtate, then the difficulty is removed, by removing the mountains, and mixing them in a chaos with the waters. In this view of the ſubject, there were no mountains to be covered, until they were afterwards formed by the high tides of the deluge; concerning which, I will offer a few obſervations. The quartz, ſhirl, and mica, and in ſhort, all the viſible fine grains found in the compoſition of our preſent ſtrata, are clear indications, and ſtrong proofs of the former exiſtence of ſuch original ſtrata as I ſpeak of. At the ſame time, it does not appear to me an eaſy matter to explain how thoſe original ſtrata were broken down and mixed with the waters. The ancient philoſopher and inſpired hiſtorian Moſes, acquaints us, that there was no rain in the antediluvian earth, but that the face of the ground was watered by miſts inſtead of rain, which is not improbable. There are ſome countries which never rain in the preſent ſtate of things; ſuch, for inſtance, as Egypt in the Old Continent, and Peru in America; and moreover, we frequently ſee thick miſts in theſe countries. A thick miſt aroſe from the north-eaſt in the ſummer of 1780, which was carried along by a conſiderable, though moderate breeze of wind. This miſt was ſo thick and heavy, that it condenſed againſt the ſouth ſide of the High Street of Edinburgh, to ſuch a degree, as not only to make that ſide of the ſtreet wet and dirty, but even to run down the gutter in a current as in time of moderate rain, while the middle of the ſtreet and the north ſide were duſty. And I ſaw the ſame miſt, when carried by the wind, condenſe againſt the leaves of trees, ſo as to run off the trees in continual great drops, which made a puddle under them, and it ran along the ſide of the road, where there was a row of trees, while a cloud of duſt was flying in the middle of the road. I ſaw this in ſeveral parts of the Lothians in Scotland. Upon the ſuppoſition of there being no rain in the antediluvian earth, the ſtrata which compoſed the ſuperficies of that earth would want moiſture, and of conſequence they would become full of cracks and chaps by drying too much; the dry external air would be admitted into their cracks and fiſſures, which would waſte the coheſion of the rocks, and haſten their decay near the ſurface.

The rains deſcending ſeaſonably upon our mountains and plains, entering the ſuperficies of our ſtrata, and percollating their pores and cranies, and paſſing through their interſtices, keeps them continually freſh, and preſerves the cementing quality in perfection. But if the antediluvian ſtrata wanted the moiſture communicated by rain and melted ſnow, undoubtedly they would crack and moulder, and approach rapidly to decay; and if, at any future time, water or exceſſive rain was to overflow or to deſcend ſuddenly upon the ſtrata thus cracked and overdried, it would have an immediate tendency to ferment and diſlocate, and burſt the ſtrata into ſmall fragments and maſſes of various ſizes.

The learned aſtronomer, Mr Whiſton, conſtantly affirms, that a Comet paſſed by the earth at the very time when all antiquity ſay the univerſal deluge happened; that the earth paſſed quite through the atmoſphere and tail of that Comet, and in conſequence of this near approach of the Comet, that the earth acquired thereby a great quantity of a watery vapour, which fell down in heavy rain upon the earth. This is not contradicted by other aſtronomers; on the contrary, the learned in general aſſert, that a Comet did appear at the precife time mentioned by Whiſton. If this Comet approached ſo near the earth as Whiſton ſays it did, beſides the watery vapour which the earth would attract from it, the Comet would certainly have a mighty effect in diſturbing our atmoſphere, in cauſing exceſſive rains to deſcend from thence, and in raiſing the tides of the ocean to a monſtrous height, which tides would overflow the land, and by their prodigious weight and force would tear up the antediluvian ſtrata, and ſoon break them to pieces, when mixed with the water. By this means, the ſhores and mural barriers of the ocean would be broken up, which would facilitate the mixing of the land and water in a chaotic ſtate.

When once the ſtrata began to be diſlocated and broken up, either by the deſcent of heavy rains upon the dry and half calcined ſtrata, or by the tides invading and overflowing the land; the fermentation and deſtruction of the parched ſtrata would advance rapidly, until the ſolid ſurface of the globe was broken to pieces, and blended with the waters of the ocean in a general chaos.

I exclude from my obſervations all concern with central waters iſſuing out of the bowels of the earth, to overflow and diſturb the ſurface. I do not know that any ſuch waters exiſt; nor is there any way for me to acquire ſuch knowledge. I have no doubt but this planet of ours has ſome relation and connection with all the other planets of the ſame ſyſtem; but what degree of denſity and gravity, &c. in proportion to its magnitude and ſituation, is requiſite to anſwer its relation to the reſt, is out of my power to know; and without this knowledge, there is no ground left for me, ſo much as to form a probable conjecture, whether the center of the earth is ſolid or fluid, light or heavy, denſe or rare, hot or cold; and therefore I will not meddle with the center of the earth. The ſuperficies of this planet is expoſed to my inſpection and enquiries, which I will purſue, and ſubmit my obſervations to the cenſure of the candid naturaliſt.

Some philoſophers oppoſe the doctrine of an univerſal deluge, from the ſuppoſition of its abſurdity, as they imagine. Theſe gentlemen alledge, that it reflects diſhonour upon a wiſe and intelligent Creator, to ſuppoſe that he would make any of his works ſo imperfect at firſt, as to require an after-change or reformation. This objection may appear at firſt ſight both plauſible and ſtrong; however, it is not ſupported by the oeconomy of nature and experience.

We find nature full of change, and generally for the better. We are moſt ſenſible of theſe changes in animated nature, where the transformations may be properly called advances to a better ſtate.

The ſordid caterpillar of laſt ſeaſon is now a ſhining butterfly, floating at pleaſure in the ambient air, and ſipping the nectar of every flower; and we hope for a greater change: In ſhort, nature is full of change or advance; but why it ſhould be ſo,—why all creatures are not made inimitably perfect and permanent at firſt,—is too deep a queſtion to be ſolved by the wiſdom and philoſophy of man. We know that it is ſo; but the reaſon of this and other inſcrutable phenomena of nature, muſt be reſolved in the wiſdom and will of God.

From many of the phenomena of nature I am led to imagine, that the antediluvian earth was created a fit and proper habitation for man in his firſt perfect ſtate of innocence; but when he fell from his firſt eſtate, and became a ſinful man, by aſpiring at independence and equality with God, he at the ſame time became a miſerable man, ſubject to many more wants than formerly, and particularly ſuch wants as are connected with the aids of ſociety, arts and commerce; which the antediluvian earth was not ſo well adapted to ſupply as the preſent. The antediluvian ſtrata were by far too hard, fine, bright and glorious, for the common uſes of ſociety. In order to throw as much light as I poſſibly can upon this great and difficult ſubject, I will ſelect a few particulars, which ſeem to point out the neceſſity and the reality of the changes we are ſpeaking of.

We have already treated of the quartz, ſhirl, and mica, and other fine grains and maſſes found in the compoſition of our ſtrata; and have hinted that theſe muſt be fragments of ſome ancient ſtrata, that is, of the antediluvian ſtrata. We ſhall take a curſory view of the principal phenomena of ſome of theſe fragments.

1ſt, Talc and mica is one of the fineſt and moſt beautiful ſubſtances in the world ; and though in general it is broken exceeding ſmall, in which ſtate it is called mica ; yet I have ſeen many fragments of it much larger than any other of thoſe I call ancient. I have, in the Highlands of Scotland, ſeen fragments of it up to four or five inches broad, and more than one inch in thickneſs ; and it is found in ſtill greater maſſes in ſome of the Ruſſian dominions, where they uſe it for window-lights, where it has acquired the name of Muſcovy Glaſs. The ſtratification of the maſſes of talc is ſo exceeding fine and perfect; that it is impoſſible to conceive how thin the laminæ of it may be divided, without ſeeing it ; and I know of nothing that is more bright, ſmooth, ſhining, and pellucid, than the thin plates of fine talc.

2d, I imagine that the larger fragments of quartz and feldtſpat, which are ſeen in ſome granite rocks, or in granite gravel, from the decompoſition of thoſe rocks, may be ranked next to the talc for the ſize and magnitude of the maſſes. I have ſeen diſtinct maſſes of feldtſpat imbedded in the granite rocks of Galloway, and other parts of Scotland, of an oblong or quadrilateral figure, up to two inches long, and more than one in breadth and thickneſs. Theſe large maſſes always appear of a finely ſtratified or tabulated ſtructure; but the leaves or ſtrata are ſtrongly cemented together, ſo that theſe fragments are not ſo diviſible as the talc.

3*d*, I ſuppoſe the diamond may come in next to the quartz, for the magnitude of its maſſes. I reckon that the diamond, and all the gems and precious ſtones, which are not of a priſmatical figure, from their being chryſtallized in the cavernous parts of our rocks, are fragments of the ancient ſtrata. All thoſe fine maſſes and grains which are of a ſtratified or tabulated ſtructure, are certainly ancient: And the diamond is known to be, perhaps, as finely ſtratified as the talc itſelf; and there is certainly no foſſil in the world that has a finer fabric, and more perfect ſtratification than talc. The diamond is ſo hard and ſtrong, that it can only be broken by ſplitting or cleaving it aſunder; but the laminæ or ſtratified plates of the diamond are ſo ſtrongly and ſo finely cemented together, that they cannot be diſcerned or any way known to exiſt, but when force is uſed to break the ſtone. The diamond, and many other gems, are found in the potatoe form, which ſhews them to have been rolled in water, until the aſperities and ſharp angles were rubbed off; and their tabulated ſtructure proves them to be fragments of ſome ancient ſtrata. But that I be not over tedious to no purpoſe, I will obſerve here in general,

ral, that the ſame thing may be ſaid of all the other fine, bright, pure, and pellucid grains and maſſes found in the compoſition of our ſtrata, which has been ſaid of the above-named. The brightneſs and beauty of their colours, the fineneſs, and the tabulated or ſtratified fabric, proves them all to be fragments of ſome ancient ſtrata; and we muſt acknowledge thoſe ancient ſtrata to be antediluvian..

Now it is remarkable, that all the gems, and moſt of the fine grains and ſmall maſſes found in the compoſition of our globe, or among the debris of the decompoſed ſuperficies of our rocks, are of various bright and beautiful colours, ſuch as red, an azure white, green, blue, yellow, &c. with various ſhades and tinges of theſe and other colours; and it is alſo remarkable, that excepting talc, all theſe grains and maſſes, from the ſmall grains of ſand up to the coſtly diamond, are exceeding hard; even ſo hard, that no tools of our tempering would be fit to pierce, or to have any impreſſion upon rocks of them. We find in our rocks fine grains of a great variety of colours, from which we may infer, that there was a great variety of ſtrata in the antediluvian earth; but as theſe colours are very bright, and the grains very hard, we may alſo infer, that thoſe ſtrata were not very fit for the common purpoſes of life. They were too hard to be quarried and worked, and too bright and glorious for the eye of man to behold in buildings, and other common uſes of ſociety.

Theſe remarks upon the antediluvian ſtrata ſuggeſt to me, that the earth was firſt formed a ſuitable habitation for ſuch a glorious, perfect and happy creature as man in innocence; but when man ſinned againſt God, by aſpiring at equality and independence of his bountiful Creator, and Sovereign Lord, he ſoon experienced a fatal change. His mind was defiled with ſinful and unruly paſſions and appetites, and his body became mortal, frail, and vulnerable. In ſhort, man then became ſinful, miſerable, and wretched, expoſed to ſickneſs, pain, and a thouſand woes and inconveniencies, which made the aids and accommodations of ſociety abſolutely neceſſary for his tolerable well-being in this world; and the Almighty did not leave him deſtitute, but pitied him in his low eſtate, and provided for his accommodation.

Although the antediluvian earth was perfectly ſuitable for the habitation of man, as he came from the hands of his Creator; yet it was not ſo ſuitable as the preſent to ſupply the various wants of ſuch frail and wretched creatures as we are now; and that, when it pleaſed the all-wiſe, benevolent, and merciful Creator to pity us in that low eſtate, into which we had plunged ourſelves, by attempting to climb too high; and when it pleaſed him to lay our help upon an Almighty Saviour, who is able to deliver us from eternal ruin, to raiſe us up, and reſtore us, even here, to virtue, dependence, and hope; the Almighty was alſo pleaſed, in proper time, to take to pieces the fabrick of our firſt habitation, and to rebuild it with additional accommodations, fully adequate to the various wants and conveniencies of miſerable man in a ſocial ſtate of induſtry and commerce.

We know very well that the ſtrata, and the minerals of the poſtdiluvian earth, are fully adequate to all the demands, and perfectly convenient for all the accommodations of ſociety; but we have good reaſon to doubt that the antediluvian ſtrata, &c. were not ſo ſuitable for our purpoſes. I am confident that there was no pit-coal in the former earth; the origin and ſource of which was the antediluvian timber, which we have already explained; and coal is of ſuch vaſt conſequence to a flouriſhing ſtate of ſociety,—to arts, manufactures, and commerce in our part of the world, that we could make but a poor figure without it, and its conſequence will increaſe in other countries as well as ours. We know that our groſs compounded ſtrata, and the order of their diſpoſition, are exceedingly convenient for our quarrying and building houſes, harbours, bridges, and for making

ing roads, &c. I doubt much if the hard and fine textures of the ancient ſtrata were fit for any of theſe purpoſes. Our coarſe compounded materials are very fit for high roads; but I would not wiſh to be obliged to travel in a ſunny day upon a pavement of diamonds, talc, and rubies. None of the virgin metals we find, ſuch as gold, ſilver, copper, will make a good edge, nor have they the ſtrength and hardneſs of iron. Iron, which is of more intrinſic value than all the gold and gems in the univerſe, appears to me to be altogether a compound mineral; and that it was prepared and diſperſed by the chaotic ſtate of the deluge, all over the ſuperficies of the globe, as we find it in ſuch vaſt profuſion, like the other neceſſary and common bounties of nature. What could we do without iron in an improved ſtate of ſociety, arts, and commerce? And ſuppoſing iron to have had the ſame quality and properties before as ſince the deluge, yet if it was depoſited in ſtrata among a multitude of other different ſtrata, as hard and impenetrable as the ſamples which we have of them, there could not a ſufficient quantity of iron be raiſed to anſwer the demands of ſociety. I do but lightly touch theſe obſcure, though intereſting topicks, and leave them to be examined and treated more amply by the intelligent naturaliſt, and he will find that the phenomena of nature favour my conjectures.

I obſerved above, that the great philoſopher Moſes has pointed at the manner of the formation of the primitive ſtrata, in the ſignificant words of the *Spirit*, or *wind of the Lord God moving upon the face of the waters*, which denotes their being put in a gently flowing motion, whereby the fine and beautiful ſtrata of the antediluvian earth were formed; and I imagine, that moſt of thoſe ſtrata were thin, but very regular; and this ſuppoſition is founded upon the inconceiveable fineneſs of the materials, or particles of which thoſe ſtrata were compoſed; and if thoſe ſtrata were generally thin and hard, they were the more ſubject to be cracked by exceſſive drought, and they would be the eaſier burſt aſunder, broken to pieces, and taken up in the waters of the deluge.

The ſame great philoſopher uſes a different language, or form of words, when he points at the deſtruction of the ancient ſtrata, and the formation of the preſent ſuperficies of the earth. He ſays concerning this ſubject, that "the fountains "of the great deep were broken up," by which I underſtand the diſſevering, and breaking to pieces the ſuperficies of the ancient ſtrata, which were the only mural boundaries of the ocean, for there was but little or no ſand then; ſand being evidently the remains of the primitive ſtrata broken to pieces, and ground ſmall by attrition in the chaotic tides. When the primæval ſtrata were broken up, Moſes ſays, that "the waters 'prevailed, and increaſed exceedingly upon the 'face of the earth." I am very much inclined to give credit to Whiſton's account of a comet's approaching and paſſing near the earth at the time of the deluge. It is generally agreed, that a comet did appear at the preciſe time mentioned by Whiſton. If that comet came as near the earth as he ſays; and if the earth paſſed quite through the atmoſphere and tail of that comet, no doubt, it would occaſion the cataſtrophe of an univerſal deluge. Upon that ſuppoſition, it is impoſſible for us to imagine, with any reſpect to the nature of things, that ſuch an event would not happen. The earth paſſing through the atmoſphere of the comet, would, undoubtedly, attract to itſelf a great quantity of that atmoſphere, which would fall down in rain upon the earth. As there had been no rain before the deluge, we may ſuppoſe that our atmoſphere was by that time plentifully charged with watery vapour; now, the attraction of a comet paſſing ſo near the earth, would raiſe a terrible commotion in our atmoſphere, which alone was a ſufficient cauſe of prodigious quantities of rain falling upon the earth; which rain, when joined by the high tides, which muſt be raiſed by the attraction of the comet, were ſufficiently powerful cauſes of an univerſal deluge. Attraction is known and acknowledged to be an eſſential property of bodies; and although they mutually attract one another, yet the greater the body, and the more matter it contains, the powers of attraction will be proportionally great. Whiſton and other aſtronomers aſſure us, that the comet which paſſed by the earth at the time of the deluge, is conſiderably leſs than the earth; from whence we may conclude, that the earth had a greater chance of robbing ſo ſmall a comet of part of its atmoſphere, than of being robbed by it. Such a comet paſſing ſo near our earth, would certainly, by its powers of attraction, greatly diſturb our atmoſphere, and raiſe the tides of our ocean to ſuch a monſtrous height, as to overflow the land; and when the land was overflowed by ſuch high and weighty tides, the weight and force of ſuch tides would certainly tear up, and break to pieces, the primæval ſtrata.

Philoſophers may be allowed to form conjectures concerning the uſe and intention of all natural bodies; and to know the real uſe of a thing, and the intentions of the Deity in producing it, is among the moſt profitable and moſt comfortable attainments in natural knowledge; and we rejoice in our participation of ſuch knowledge. What if the uſe of comets ſhould be to carry ſuch ſupplies to the planets as may be neceſſary and uſeful, to bring about revolutions, changes, or advances, by fire or water? The decay, the waſte, and the deſtruction of one body, animal or vegetable, &c. in our world, is made uſe of for the well-being of another: But this myſtery is too deep for me; and therefore I will content myſelf with the bare hint.

We have nothing in nature capable of aſſiſting the imagination to conceive proper notions of ſuch monſtrous tides, as a chaotic ſtate of the terraqueous globe would be raiſed to; any thing that we have ſeen, or can ſee, of floods and inundations, being too trifling to aſſiſt our ideas. Mr Ferguſſon's chapter upon Tides is perhaps the beſt illuſtration of this ſubject, and the beſt aid we can get to aſſiſt us in forming proper ideas of thoſe tides.

When once the tides were by any means raiſed ſo high as to invade and overflow the land to a great depth, there is no room to doubt, that the violent ruſhing forward from eaſt to weſt, of ſuch a prodigious weight and depth of water, would ſoon tear up and deſtroy the ſolid ſuperficies of the globe. I have had a good deal of experience and obſervation in a practical branch of mining called *huſhing*; which is frequently practiſed in making trials for mineral ores upon ſloping grounds, and ſometimes for huſhing or ſcouring the rubbiſh out of old works, in order to get what ore has been left in the rubbiſh. Huſhing is performed by making a huſh-dam or reſervoir, with a ſluice as high up as water is to be had; and by cutting a trench in a right or a diagonal line down the ſlope, and letting out the water to ſcour and deepen the trench, or huſh-gutter down to the bare rock, in order to make diſcoveries. When this operation is ſo far completed, that we have waſhed or huſhed away every thing off the face of the rock within the gutter, it cannot be imagined, nor if told would it be believed without ſeeing, how the ſolid ſurface of the rock is torn up and carried down the huſh-gutter by the weight and force of the water; and if two or three feet deep of water, blended with ſtones and rubbiſh, can do ſo much, what may we not ſuppoſe twenty or thirty thouſand feet deep capable of doing.

We have, perchance, ſeen a ſmall branch of a river break out of its channel in a flood, and take a new courſe, and then we have ſeen what havock that ſmall current has made upon the face of the ground.

But every thing that we can ſee or think of is ſo very diminutive and trifling, as not to be ſuited to raiſe our ideas to proper conceptions of the amazing weight and force of tides riſing ſeveral miles in height, and ruſhing forward in the full force of ſuch a height. When the waters of the deluge had ſo far "prevailed" as to break up the primæval ſtrata, and to blend them in thoſe high tides which overflowed all the land; it is pretty eaſy to conceive, that the prodigious and unequal agitations of ſuch tides, in their periodical motions weſtward, would be fully adequate to grind down the fragments of thoſe ſtrata by attrition, into ſuch grains and particles as we find in the compoſition of our ſtrata.

When we reflect upon ſuch a chaos,—a world of water and broken rocks, blended together in monſtrous agitation and forward motion, and all the ſtones continually grinding one another, by rolling and attrition, in the violent progreſſive motions of ſuch tides of the chaotic maſs; it is a wonder that any grains and fragments are left ſufficiently diſtinguiſhable to give us any notion of their being primæval ſtrata, and that they are ſuch, I have clearly proved before.

When the remains of the primæval ſtrata had been rolled about long enough in the agitations of the chaotic tides, to prepare the debris of them to be fit for being formed in ſuch ſtrata, as would be moſt ſuitable and convenient for the various purpoſes of the poſt-diluvian earth, the moſt violent agitations of the chaos began then to abate, and the ſuperficies of the earth began to be formed a-freſh, of the various coarſe grains which were ground down and blended together in the waters.

I hinted before, that part of the ſolid ſurface of our globe, ſuch as the granite rocks, compoſed of large grains and maſſes, was formed by ſubſidence in deep water, which I ſuppoſe to be done when thoſe high tides were in ſome degree of reſt, about the height of the tides; and that the more regularly ſtratified parts were formed by water in motion, when the tides were moving weſtward after the Sun and Moon.

Behold in the granite and porphyry rocks, a clear demonſtration of the truth of my natural hiſtory of the ſuperficies of the globe. Some of the granite rocks of Lochaber in the Highlands of Scotland, and many others which I have ſeen, are wholly compoſed of large grains of exceeding fine ſtones of various bright and beautiful colours, cemented with the ſame, which rocks were deſcribed above. Now, theſe large grains and ſmall maſſes of the primæval ſtrata, were too heavy and bulky for floating long in the chaotic ſtate of the deluge; and therefore, this gravel-like matter ſubſided firſt, immediately when the rage and violence of the firſt chaotic ſtorms began to abate, and this coarſe or large grained matter ſubſided before it was any way debaſed or mixed with heterogeneous matter not ſo pure and pellucid. Some of the fine granite and porphyry rocks, ſuch as that of Bineves in Lochaber, are perfectly fine and pure throughout, being wholly compoſed of the debris of finely coloured pure and pellucid ſtrata of the antediluvian earth, cemented by a fine ſand of the ſame. Moſt of the huge and miſhapen granite rocks of the world are of this deſcription, in reſpect to the large ſize of their grains, though they are not all compoſed of equally beautiful materials. The Lochaber granite, and many others which I have ſeen, would perhaps be the moſt beautiful ſtones in the world when poliſhed.

The great naturaliſt Moſes points at the formation of our ſtrata, after the deluge was paſt the height, in very few, but expreſſive words: He tells us, that this great operation was performed by the agency and motions of the returning reiterated tides. After informing us that "the rain from Heaven was reſtrained," he ſays, that "the waters returned from off the earth continually;" or that "the waters were continually going and returning:" which words clearly point at the ebbing and flowing of the tides, or, as he expreſſes it, the going and returning of the high tides in the chaotic ſtate of the terraqueous globe: And a little forward he ſays, in his very brief and expreſſive narrative, that "the waters decreaſed continually;" or that "they were continually going and decreaſing." Geneſis 8.

The beſt mode of expreſſion is in the margin of the London Baſkett's Bible of 1741, and ſome others. Moſes plainly points out to us the decreaſing of the height of thoſe tides, as the matter which compoſed our rocks and ſtrata was ſeparated from the waters of the ocean. I know very well that it is very unfaſhionable to make mention of Moſes, or any way to allude to his writings in a work of this nature; but if Moſes's writings and the book of nature agree and correſpond together, I incline to do him juſtice. I have not yet met with any thing that contradicts him, in all my reſearches into the Mineral Kingdom; and if Moſes and Nature ſpeak the ſame language, why ſhould I reject his account of theſe matters? I have attentively examined theſe ſubjects, in a ſedulous perſevering ſearch of truth, with an impartial eye, and I find Moſes and Nature agree; and whenever philoſophers will take the trouble to compare my imperfect writings with the perfect originals in the book of nature, they will then be fully convinced of the truth of Moſes's brief, but perfect narrative.

We may add to the above particulars, from the Mineral Kingdom, a very powerful argument in favour of an univerſal deluge, deduced from the diſtribution of the various kinds of animals over the different parts of the earth; and if this matter is examined impartially, it may be conſidered as a deciſive proof of the queſtion.

We know that Noah's Ark grounded upon Ararat, one of the higheſt mountains of Armenia in Aſia; from whence, the inhabitants of the poſt-diluvian earth, man and beaſt, were gradually increaſed and ſpread over the whole face of the earth.

When Columbus diſcovered America, in 1492 of the Chriſtian æra, there was neither elephant, rhinoceros, camel, lion, ox, nor horſe in the new world, nor any other tame nor wild animal that is peculiar to the torrid zone, and to the other warm climates of the Old Continent.

Moſt or all the quadrupeds found in America, were ſuch as are found in cold climates, or indifferently, either in cold or warm climates.

This remark merits the conſideration of natural philoſophers. I know very well, that our learned philoſophers, who either deny or doubt the reality of an univerſal deluge, are very well informed of the comparatively ſmall number of quadrupeds found in America; yet, perhaps, they have not conſidered this well known fact, as having any relation or connection with the proofs of the deluge. But however that may be, I am bold to aſſert, that this hiſtorical fact is a clear proof of that great cataſtrophe.

The natural cauſe of this ſingular phenomenon deſerves to be inveſtigated.

I have been long perſuaded, that the continent of America is joined to the north-eaſt of Aſia; and the reſearches of the juſtly celebrated Captain Cook, in his laſt voyage upon the weſt, the north-weſt, and the north-eaſt coaſts of America, has cleared up this geographical difficulty, and decided the queſtion beyond a doubt in favour of my opinion.

I am further perſuaded, that America was at firſt peopled by land from the north-eaſt of Aſia, and that the native Americans derived their remote origin from ſome of the eaſtern Tartars of the cold regions to the north of Corea, or of the northern parts of Ruſſian Tartary.

The copper colour, the thin beards, and the general character and manner of living of the Northern Tartars, and the Americans, favours this hypotheſis. The emigration of the Tartars to America muſt have happened in a very early period, before the frozen ſnows of the northern regions were accumulated to ſuch a degree, as to block up the paſſage between the two continents. At preſent, there is no paſſage between them by land, on account of the mountains of ſnow, which have been accumulating for four thouſand years. However, this accumulation of ſnow would not begin immediately after the flood. It is natural to ſuppoſe, that the froſt and ſnow of winter would thaw and melt away in ſummer in the northern regions for a conſiderable time, as it does now in more temperate climates. Perhaps, the froſt and ſnow of the valleys might continue to thaw and melt away for ſeveral ages before the mountains of ice and frozen ſnow began to accumulate over the whole face of the immenſe regions of the north; though the ſnow is now heaped up to perhaps many miles of perpendicular depth over the face of the valleys, as well as the mountains. The mountains of ice and frozen ſnow would begin by ſlow degrees. At firſt, ſome little ſnow would remain upon the higheſt mountains all ſummer, which would increaſe by degrees, untill it began to remain over ſummer upon the loweſt hills; and this increaſed quantity of ſnow would increaſe the rigours of the ſeaſons and climate, which would become more and more cold and ſtormy every year; and at laſt, a ſevere ſeaſon would pour down ſuch a vaſt quantity of ſnow, that the next ſummer's ſun could not melt it off the valleys; and then the foundation was laid of the preſent mountains of ice and ſnow; and more is piled up and built upon this foundation every year. The quadrupeds found in America, when Columbus diſcovered that continent, would proceed there from the Old Continent long before the rigours of the climate would increaſe to this extremity of cold. Wild beaſts love to roam at pleaſure, excepting when they are purſued by their enemies, or ſhun the reſorts of men, and the haunts of more powerful ravenous animals. Beaſts, as well as men, make war upon, and deſtroy one another. The harmleſs, the timid, and the weak of the brute creation, fly from, and ſhun the cruel, the ſtrong, and ferocious. The wild beaſts of prey, and ſuch as were not immediately domeſticated or tamed for uſe, would be turned looſe in the country of Armenia, to ſhift for themſelves as ſoon after the flood as the earth was in proper condition to produce abundance of fruits, roots, and herbage for their ſuſtenance.

Armenia being ſituated in about 40 degrees of north latitude, ſuch beaſts as delight in cold climates would ſoon ſpread to the furtheſt northern latitudes; and the weak and timid would advance faſter than natural inclination prompted them, being obliged to flee from their numerous enemies. Theſe natural cauſes, and natural propenſities, would bring a variety of quadrupeds into North America, before the whole face of the northern regions were covered over with eternal ſnow: And it may be obſerved, no quadrupeds were found in America when Columbus landed there, but ſuch as can live a conſiderable time in the woods. Captain Cook found the coaſts of the moſt northern parts of America covered with wood; and no doubt, the inland parts were woody before the mountains of frozen ſnow began to accumulate. Many of the quadrupeds would live in the northern woods for ſome winters, before they advanced further ſouth, and they would be ſubſiſted, ſome by browſing, and ſome by preying upon others. But moſt of them would advance rapidly towards the ſouth; the timid being propelled by their enemies, and the carnivorous purſuing their prey. The bear, and other ferocious animals of the cold climates were found in America when firſt diſcovered; but there was neither lion nor tiger, nor any other of the fierce inhabitants of warm climates, excepting one ſpecies of panther, or ſome other kind of the ſpotted tribes. Some of the earlieſt Spaniards of America might introduce a breed of theſe fierce animals from Aſia, with a view of training them for the chace, to hunt the deer, and other harmleſs American animals; and theſe might break looſe, run wild, and ſoon fill the woods with their progeny. The cruel character of the Spaniards at the period of their firſt conqueſt of Peru, fully juſtifies ſuch a conjecture: And the hunting of leopards is very common in Aſia.

There is another way of accounting rationally for the appearance of this ſpecies of leopard in

America. A pair of them might purſue the lama and pacos northward, in a very early period, and never give over the chace, until thoſe harmleſs creatures ſettled among the precipices and ſnows of the Cordilleras, where their ſpotted enemies could not ſubſiſt for cold, nor could they run as faſt as the lama among the rocks and ſtones of thoſe mountains. There are none of theſe camel-ſheep in any part of the Old Continent that I know of. In their wild ſtate, among the Cordilleras and Andes, theſe harmleſs, uſeful creatures are ſo vigorous, lively and fleet, that they bid defiance to the chace of every other animal whatſoever. They can only be taken or killed by ſtratagem, even when they come down to the lower ſkirts of the mountains. Nothing can come near them when they take the alarm and begin to run off.

The lama and the pacos are only found in South America, where they have a tame breed of them; and they are harmleſs, uſeful creatures, but incomparably more ſlow and phlegmatic than in the wild ſtate. In that ſtate, where they enjoy perfect freedom, and a choice of food and climate, theſe creatures are exceedingly active and ſtrong; they delight in the regions of ſnow, among the coldeſt mountains of South America; and are ſaid to be found among the range of theſe mountains, as far ſouth as Patagonia. In the wild ſtate, the lama is called guanaco, and the pacos, which is the ſmaller of the two ſpecies, or varieties of American ſheep, is, in its wild ſtate, called vicuna. It is ſaid, that the vicunas are ſtill fonder of the ſummits of mountains, and of the coldeſt regions of ice and ſnow, than the lama.

Now, the lama and pacos being only found in America, and not in any part of the Old Continent, and their delighting in the higheſt, and conſequently the coldeſt ranges of mountains in the world, favours my conjecture, that theſe harmleſs creatures would wander from Armenia towards the north; and that they might be chaſed by the American leopard, in a very early age of the world, as far as the Cordilleras, before they found a place of perfect ſafety from this ferocious enemy. The lama and pacos not yielding ſuch fine fleeces, and perhaps not ſuch fine fleſh as our ſheep; and being more capable of ſecuring their own ſafety among the roughneſs and cold of the higheſt mountains, would be turned looſe by Noah and his ſons. The ſheep was more worthy of their care, and they had more need of it, being, comparatively, but ſlow of foot, timid, and defenceleſs. And moreover, the firſt men had no inducement to incumber themſelves with the care of any other animals of this kind, as the ſheep would afford them abundance of the fineſt fleeces, and of the beſt and moſt wholeſome animal food.

War is as natural to the ſavage ſtate of mankind, as to the civiliſed. It is rather more incident to the ſavage, hunting being a ſort of proper education for training up the ſavage for war; and the cauſes or motives of their wars are as common and as trifling, if not ſtill more trivial and frivolous.

The concerns, the privileges, and pretended laws of the chace, breed as many quarrels among the ſavage, as the diſputes about teritory and the affairs of commerce among the civilized nations.

The firſt emigration of the Americans from the Old Continent, might have happened in conſequence of the loſs of a battle,—the loſs of their domeſtic animals, or of their grazing and hunting grounds, which the conquerors would take poſſeſſion of. In this caſe, the conquered would be obliged to fly northward, to conceal themſelves in the woods; and if reduced to few in number, they durſt not return for fear of being all maſſacred.

The laws of war among the Americans, to this hour, is implacable revenge and deſtruction; not to ſubdue for the honour and advantages of the victory, but if poſſible, to murder and exterminate the whole race of their enemies. This kindred feature of ancient Tartarian barbarity, has been ſufficiently exemplified, both in the old and in the new world, to prove the kindred and ſimilarity of character and manners of the Tartars of both continents. Jenghiz-khan in the old, and the Iroquois in the new world, are well authenticated proofs of the juſtice and propriety of this obſervation. The celebrated barbarian Jenghiz-khan murdered millions without cauſe, or hardly any pretence of provocation; and if he and his blood-hounds had lived long enough, they would have exterminated moſt of the human race out of the Old Continent; and his kindred in the new always ſhewed as good will, only they wanted equal power.

If we are rather inclined to ſuppoſe that the firſt emigration of the remote anceſtors of the Americans was voluntary, and not the reſult of the fate of war, or other abſolute neceſſity, this will make very little alteration of future circumſtances. In this caſe, the whole horde or hordes would remove with all their beſtial, and other effects (a ſhort inventory), in the ſame manner as the hordes of Tartars have always removed from place to place, in all ages down to this very time; yet, even upon this ſuppoſition, there could be no more domeſtic animals in America, than the Europeans found there in the fifteenth century. Suppoſing they carried numbers and variety with them, they muſt all die by the way of cold and hunger, in the inclement and barren regions of the north, which Captain Cook found to be exceedingly extenſive. It is natural to ſuppoſe that the emigrants themſelves would have great and inſufferable hardſhips to encounter in paſſing through theſe dreary, extenſive, and inhoſpitable regions, and that they would be reduced to few in number, and to a miſerable condition, before they arrived at, and ſettled in more temperate and fruitful climates. In this journey, and in theſe circumſtances, their ſavage ſtate was very much in their favour, being accuſtomed to live hardily, and to kill and ſubſiſt upon wild beaſts; they would find ſome of theſe by the way, which would often ſupply their wants; and as the inland countries might then be ſhut up with ſnow, it is probable that they would travel by the weſt coaſt, in which route they would find abundance of ſhell-fiſh in moſt places. It is very probable that the ſea-coaſt was the only open paſſage. Captain Cook found every mark and appearance of a great and extenſive continent in the moſt north-weſtern parts of America. The river Turnagain, which falls into the ocean about the latitude ſixty north, is one of the largeſt rivers in the world; the ſhores of which river, and of the ſea thereabout, was covered with ſnow in ſummer down to the very beach ; and it is very well known, that ſuch rivers always derive their ſources from great and extenſive continents. But notwithſtanding the rigours and the eternal ſnows, Captain Cook found theſe dreary regions inhabited by a race of ſwarthy people of low ſtature, the effects of the climate ; and it was very evident, that the inhabitants muſt depend entirely upon fiſhing and hunting all the year round, as nothing could be got from a land eternally covered with ſnow.

This hiſtorical fact lately diſcovered ſuggeſts to us, that only ſome of the firſt emigrants, or of their immediate poſterity, puſhed forward to the temperate and warm climates of America, and that ſome of them remained by the way in the moſt diſmal regions of the north, where they found a wretched, but ſure ſubſiſtence, by fiſhing and hunting, which became agreeable by cuſtom, and a ſenſe of the tranquility of their ſituation, far from the danger and diſturbance of powerful neighbours. The powerful effects of long habit has brought the Eſquimaux to prefer the eternal ſnows and rough ſeas of Labrador to all the reſt of the world. But although the Tartarian emigrants could be ſupported by the ſea, and by the woods, in the long and tedious paſſage by the north-weſt coaſt of America, until they arrived in warmer climates and an open country ; yet the domeſtic and uſeful animals of the old continent muſt all periſh by the way, and very ſoon too, there being nothing in the world for them to eat, during the long winters of the north, in a paſſage of ſeveral thouſand miles. The weſt and north-weſt of America, from latitude 44. to the junction of the American and Aſiatic continents, is ſaid to be three thouſand ſeven hundred miles, in the account of Captain Cook's laſt voyage. We are not however to imagine, that all this great length of coaſt is conſtantly covered with ſnow; but we may confidently aſſert, that at leaſt one third of it is perpetually covered from generation to generation; and we may as confidently aſſert, that one thirtieth part of it, when totally covered with ſnow, is ſufficient to kill all the domeſtic animals of the Old Continent, where they could get neither provender nor ſhelter from the rigours of the climate. The whole of this immenſe diſtance would be covered with a great depth of ſnow, through the whole length of every winter; and the moſt of the ground in the northern climates conſiſts of boggy moraſſes, and of woodland, where man might find game to kill; but our uſeful animals would find nothing to eat, nor could they find any ſhelter; and of conſequence, none of them could be preſerved alive; and none of them were found in America when the Europeans landed there in the fifteenth century. And it may be inferred,—I might ſay proved, from this very circumſtance, that America was at firſt peopled by the north; and that the firſt inhabitants walked there by land. Had they gone there by ſea, they would have carried ſome of the domeſtic animals of their own country with them; but none of ours were found in all America.

It may be objected to this, that it is not probable the native Americans derived their origin from the Tartars. The Tartars have had the art and cuſtom of taming animals in all ages, and of making uſe of them, at leaſt, for carrying burdens, and for ſupplying milk and fleſh for their ſubſiſtence. The Americans, on the contrary, had not the art of taming animals; nor had they any knowledge of their domeſtic uſes when Columbus diſcovered their country; and therefore, it may be inferred, that the original Americans muſt have arrived there from ſome iſland which had not the knowledge and uſe of domeſtic animals. In anſwer to this objection, I would aſk, how they could tame and uſe what they had not, and what was not in their power to have? There was no domeſtic animal of the Old Continent in all America when Columbus landed there; of conſequence, it was impoſſible for the natives to tame and domeſticate what they had not. The only native animals in all America, capable of being domeſticated, and made conſiderably uſeful, were the lama and pacos; and theſe were tamed and uſed by the Peruvians for carrying burdens, and for food and cloathing. However, I am of opinion, that the celebrated founder of their Empire, and their wiſe law-giver Manco Capac, learned them to tame and make uſe of theſe animals, as well as the other arts and civil inſtitutions which he eſtabliſhed among them.

The wiſe founder of the Peruvian Empire would ſoon want the fleeces of the lama and pacos to cloath his own family; and therefore, he would procure young ones and tame them, and their great ſize and ſtrength would ſuggeſt to him the thought and the experiment of uſing them for burdens, in the hilly country of Peru, where they had no other animal fit for ſuch an uſe; and when they became plenty, they would try their fleſh, and find it good and wholeſome food.

Whether the original Americans were at firſt driven into the deſarts of the north by ſavage wars, or that they voluntarily emigrated, or gradually moved and advanced northward, they would be very ſoon deprived of all their domeſtic and uſeful animals, either by the war of their brethren or of the elements. They could not ſurvive one winter without any manner of ſhelter, or of provender, in the dreadful rigours of the north. The emigrants themſelves would be a long time by the way, perhaps ſo long, that the men and women born in Tartary would be all extinct before they arrived in the temperate and warmer climates; of courſe, they muſt have loſt all knowledge of the domeſtic and uſeful animals of the old world, as well as their uſe, and the art of taming them; and it was impoſſible for them to recover this knowledge and art, when they had none of theſe cattle. The lama and pacos were only found among the lofty mountains of South America, and it would hardly occur to the barbarous ſavages of thoſe regions, to domeſticate them before Manco or Madoc arrived among them. They were not domeſticated themſelves till then. We obſerved before, that the emigrants muſt have ſuffered great and intolerable hardſhips by the way, during a very conſiderable length of time; and nothing in the world has a greater tendency, and more powerful effects in reducing mankind to a ſtate of abſolute ignorance and ruſticity, than long and inſufferable hardſhips, even ſuppoſing them to have been derived from a civilized origin; but we have ſhewed, that the remote origin of the Americans was the Tartars of north-eaſt Aſia, who have always been a ſavage, barbarous, and ferocious banditti; and theſe reflections may ſufficiently account for the ſavage barbarity of the Americans, and for their extreme ignorance of, and averſion to the manners and cuſtoms of the old world, when they were firſt diſcovered by Columbus; and the caſe is not yet much altered. Where they are not under the immediate force of ſome powerful impulſe or reſtraint, they are not yet more placable or civilized, nor have they altered their cuſtoms or manners; and the ſame may be ſaid of their anceſtors the Tartars. The Tartars have continued in a ſavage ſtate of barbarity for more than four thouſand years paſt, though ſurrounded by civilized nations, and poſſeſſing immenſe regions of the beſt lands and climates in the world, ſituated in the temperate zone, which they neither plough nor dig; no wonder, then, if their brethren the Americans are ſo attached to the ſavage ſtate,—ſhould have forgot their origin, and were found ſo ignorant and averſe to our manners and cuſtoms.

Let us now conſider the force and import of theſe facts and reaſonings, as far as they are connected with the proofs of the univerſal deluge.

The records, the traditions, and belief of all antiquity, leave no room for us to doubt, that Noah's Ark grounded upon Mount Ararat in Armenia, which is ſituated as near the center of the Old Continent as can be imagined; a proper center from whence to diſtribute all the future

ture inhabitants of the earth, man and beaſt.—America is connected with the Old Continent by the extremities of the north; but the Ark, with all the land animals, grounded in Armenia, where they muſt propagate, and from whence they muſt ſpread abroad and repleniſh the earth. From this arrangement of things, and of ſituation and climate, only a very few kinds of the large, the noble, and the uſeful animals, could reach America, and theſe few only ſuch as could bear the rigours of the north, or that could paſs quite through the moſt inhoſpitable climate in a ſhort ſpace of time during the ſummer ſeaſon; or ſuch as could defend themſelves againſt the effects of the extreme coldneſs of the climate, and find ſubſiſtence by the way to ſupport them during a long peregrination.

If we take but a curſory view of the conſtitutions of the larger quadrupeds, we ſhall be convinced, that according to theſe obſervations, not many of them could reach America. Among the harmleſs and domeſtic animals, the elephant, camel, bull, horſe, aſs, ſheep, ſwine, &c. could not bear the cold and rigours of the north; nor could they find proper and neceſſary food and ſhelter in paſſing through it to warmer climates. Among the large, ſavage, and ferocious animals, the lion, rhinoceros, tiger, &c. could not bear the cold of the north, nor could they find ſhelter from the rigours of the climate and ſeaſons.

Let us now take a view of the natural hiſtory of America, when Columbus diſcovered that great continent in the fifteenth century; and in this view, we ſhall not find ſo much as one of the above-named animals among all the quadrupeds of the new world in that æra. If we divide the larger kinds of the land animals which were natives of America when firſt diſcovered, into the harmleſs and the ſavage, we ſhall find but a few ſpecies of the former, and not a long liſt of the latter, over the whole bounds of that immenſe continent. Among thoſe of the former character, muſt be reckoned the lama and the pacos, and ſeveral ſpecies of deer. This is but a ſmall number and variety; but however ſmall it is, I do not know that there was any other large animal of this character in all America when firſt diſcovered; and it was phyſically impoſſible that there ſhould be any more, unleſs they had been carried there by ſea, as the European nations have done ſince that period. The lama and pacos delight in the ſummits and frozen ſnows of the higheſt mountains; and therefore, from a conſideration of the nature of things, we might expect to find theſe in the New Continent, becauſe theſe would not feel the rigours of the north; they could ſecure themſelves from their enemies in the ſafe retreats of rocky precipices, and ſuch places as are inacceſſible to all other large animals; and they could ſubſiſt in winter upon the branches of trees and ſhrubs, without water; and theſe are found in America, and in their natural ſtate, among the Cordilleras and the Andes, the higheſt ranges of mountains in the world, which are places ſuitable to their conſtitutions, and for their ſafety. Various ſpecies of the cervi, or deer kinds, are almoſt the only large harmleſs animals found in the new world, beſides the lama and pacos. All the deer kinds can ſuffer cold, being defended by thick furs, and they can ſubſiſt in winter upon the branches and the bark of trees and ſhrubs; and therefore, it was natural to look for theſe in America, and they were found there. Among this ſmall number, the lama and pacos were perhaps the only animals which the Americans could domeſticate and bring to any conſiderable degree of utility, and theſe were tamed, and uſed for burdens, food, and cloathing. The native Americans killed the wild deer for food, and uſed their ſkins for cloathing; and there is generally no further uſe made of theſe animals in the Old Continent, excepting that the Laplanders domeſticate the rein deer, train them to draw ſledges upon the ice and ſnow, and uſe their milk and fleſh as we do the cow's.

It is ſaid that rein deers are found in the northern parts of America, but whether they are tamed and domeſticated there or not, I cannot tell.

The large ſavage ferocious animals of America are not much more numerous than the uſeful and harmleſs. Various ſpecies of bears may be reckoned the principal of theſe for ſtrength and magnitude. Bears are common inhabitants of the moſt northern regions of both continents; and they agree ſo well with a cold climate, that they frequently burrow beneath the ſnow in winter; and therefore, it is very natural to find theſe animals in America. Among the ferocious animals of America, the next to the bear in ſize and ſtrength, is a ſpecies of leopard or panther. I obſerved before, that probably ſome Spaniard introduced a breed of theſe, with a view of hunting deers and other large animals with them; which might break looſe as ſoon as landed, and then they would ſoon multiply.

The cold regions of the north is not perfectly natural to the conſtitution of this ſavage animal; but as he is carnivorous, he might purſue his prey far to the north in an early age, and when he was there, he need not take up much time in paſſing through to warmer climates.

If we ſuppoſe that a number, or a pair of theſe, followed the lama and pacos northward, until they arrived in America, and that the one ſort never gave up the purſuit, nor the others their fears, till the lamas gained the ſummits of the Cordilleras, where they could live in perfect ſafety, we may then account for our finding theſe camel-ſheep, and a ſpecies of leopard in the New Continent, and for our finding none of this kind of ſheep in the old. The lama and pacos either went northward of their own accord, or were purſued in an early age, before they had time to ſtock the mountains of Aſia, where the lion, tiger, and all their enemies were ready to devour them. But after all our reaſoning about the American leopard, it is very probable that he was introduced by the Spaniards. South America is now terribly infeſted with immenſe multitudes of wild dogs, which are extremely ferocious, though it is certain there was not one dog in the whole continent when firſt diſcovered by Columbus. The whole aim and purſuit of the firſt Spaniards in America was gold, ſavage pleaſures, and the deſtruction of the defenceleſs natives. They were ſo cruel, barbarous, and regardleſs, that we need not wonder at their introducing any future evil; and it is now extremely difficult, herhaps impoſſible, to aſcertain the civil and natural hiſtory of Spaniſh America, when firſt invaded and deſtroyed by theſe cruel barbarians.

The wolf, I ſuppoſe, is the third American ſavage animal for ſize and ſtrength. But the wolf dwells among the Alpine ſnows of all countries, and he is ſo ravenous, that he will purſue his prey into any country or climate; and therefore, it is natural to find them in America.

There is alſo a great variety of monkeys in America, which generally are not carnivorous, though many of them are remarkably ferocious, and the mildeſt of them delight in miſchief. The ſimia, or monkey race, are very widely ſpread in both continents; they delight in woodland countries, but they are found much farther north in America than in the Old Continent.

With reſpect to the fox and the other numerous races of the furry quadrupeds, the north is their native climate; and therefore, we need not take any further notice of them.

Theſe facts are remarkably ſingular and ſtriking, and not eaſily accounted for upon any other hypotheſis than that of the univerſal deluge. But if we allow, that Noah's Ark, with all the land animals, reſted upon Ararat, near the center of the Old Continent, every difficulty is then removed out of the way, and the ancient hiſtory of America is eaſily underſtood. Upon this ſuppoſition, the extreme ignorance and ſavage ſtate of the Americans becomes natural and ſelf-explained.

The Tartars, a ſavage and barbarous people, from the beginning have always inhabited the vicinity of Armenia in the Old Continent; and it was natural for ſuch ſavages to penetrate the woodland countries of the north, and procced to America, and there they were found, with very little alteration in their perſonal appearance, and ſtill leſs in their cuſtoms, manners, and general character. They are to this day the very ſame people in both continents, without any material change or alteration, in ſuch a vaſt length of time and diſtance.

Every thing becomes plain and natural when taken in this light. If the Ark, with all the land animals, reſted in the Old Continent, there could not be many of the large animals in America, unleſs they had been carried there by ſea; becauſe they could not bear the rigours of the north, nor ſubſiſt among the northern ſnows; and accordingly, no large quadrupeds were found there, but ſuch as can bear the cold of northern regions. Neither elephant nor camel, horſe nor cow, lion nor tiger, were found in America when Columbus firſt landed there. All the quadrupeds which are found in the cold climates of the Old Continent were alſo found in America, and no others; and this proves clearly, that the Old Continent is the original ſeat of all the land animals; and it alſo proves, that the firſt men went to America by land. Had they gone there by ſea, they would have carried ſome of the uſeful and domeſtic animals of the Old Continent with them.

In ſhort, every thing that comes under our conſideration relating to this ſubject in both continents, mutually prove and illuſtrate one another.

I might here produce the evidence of ancient hiſtory in favour of the univerſal deluge, to corroborate and confirm what I have advanced about the diſtribution of the larger quadrupeds in both continents, as almoſt all lettered nations have recorded that event, either as an hiſtorical fact, or as a generally received tradition; eſpecially the Jews, Egyptians, Babylonians, Greeks, and Romans; and ſome of the ancient writers upon this ſubject agree with Moſes in the principal particulars recorded in the book of Geneſis concerning the deluge; only their account is not ſo diſtinct, judicious, and conſiſtent, as that of Moſes, whoſe narrative is perfect, though conciſe. But I have neither letters, abilities, nor ſkill, for hiſtorical diſquiſitions; aud therefore, I will ſtick to my own province, the Mineral Kingdom, where my labours may be uſeful, and will leave the hiſtorical part to ſome learned philoſopher, who ſhall be convinced of the truth of my propoſitions, and of the integrity of my intentions; and from theſe convictions, ſhall reſolve to compleat what I have begun. Some good philoſopher may hereafter think it worth his while to explain and poliſh my imperfect work, and to add the evidence of ancient hiſtory to confirm and illuſtrate a work of ſo much importance to the learned world.

A brief recapitulation of the ſubjects treated of in the former pages, may be of uſe to bring the principal particulars under one comprehenſive view, in order to impreſs a general idea of the ſeveral facts upon the memory.

1. I have taken a general view of the prevailing ſtrata of Great Britain; which may be conſidered as an epitome of the whole ſolid ſurface of our globe; and I have obſerved, that ſome o theſe are ſtratified, and that ſome of them are not, and the different degrees of ſtratification are pointed out with preciſion; and the facts and deſcriptions in natural hiſtory treated of under this head, will make gentlemen better acquainted with the foſſil part of their eſtates and country than they were before.

2. I have given the natural hiſtory of the ſtratification of the ſuperficies of the globe in a full and particular manner; and of the bearing, ſlope, and continuity of regular ſtrata, and alſo of the

fiſſures, chaſms, and other interruptions of the regularity of the ſtrata; all of which point out and prove the agency of water in motion, from which we are obliged to infer, that the ſolid ſurface of our globe was formed by the revolutions and various motions of returning tides.

3. I have examined part of Count Buffon's theory of the earth, and compared it with the real ſtructure of the ſurface of our globe; and it will appear to the intelligent and candid reader, that the great French naturaliſt was extremely deficient in the knowledge of this part of his ſubject.

4. I have treated of the natural hiſtory of mountains, and of their glens and excavations. I have thoroughly examined their interior and exterior phenomena; and when the intelligent philoſopher peruſes the hiſtory of mountains, my obſervations upon this difficult, but ſublime ſubject, will prove clear, convincing, and ſatisfactory.

5. I have looked into the interior quality and ſubſtance of many of our rocks and ſtrata; and I find that they are compound bodies, containing a great number of ingredients or component parts, of various qualities and colours, diſtin-

guiſhable from one another; and I obſerve, that the different articles found in the compoſition of our ſtrata have each of them a diſtinct appearance and quality, and a regular form and ſtructure of their own, independent of their ſituation, connection, and relation to our rocks and ſtrata: Such, for inſtance, are the fragments of talc, and others, which are found, and eaſily diſtinguiſhed, in the compoſition of many of our rocks; and beſides the larger maſſes, which may juſtly be called fragments, many of our ſtrata are compoſed of ſmaller, but viſible grains, of different ſizes, and of various colours; but they all agree in this particular, that each of them is a diſtinct and a real ſtone, apparently homogeneous, and of a remarkably fine and uniform texture; but it is abundantly evident, that we have no rocks nor ſtrata in the ſuperficies of the preſent earth, of the ſame quality and texture, from whence theſe grains and fragments might have derived their origin.

All our rocks are compound bodies, in which we can diſtinguiſh a variety of different parts; on the contrary, each of theſe fragments appear fine, pure, and homogeneous, of an uniform texture, and ſome of them regularly ſtratified, as the talc, &c. and therefore, we are obliged to conclude, that theſe are all fragments and remains of antediluvian ſtrata, which have been broken to pieces, and agitated in the tides of the univerſal deluge, before they were lodged in our ſtrata.

6. I have taken a curſory view of foſſil ſhells, foſſil plants, foſſil bones, and other remains of the animal and vegetable kingdoms, which are found in the compoſition of our rocks and ſtrata; but as this part of my ſubject is generally well underſtood, and has been treated at large by others, I have only briefly glanced at this part of natural hiſtory, merely to ſhew its coincidence and agreement with the other parts of my ſubject. I have ſelected ſome particular ſtrata for examination, ſuch as the ſtrata of coal and of ironſtone; the origin, ſituation, quality, and ſtructure of which, I have pointed out and deſcribed; and from the conſideration of theſe ſeveral particulars, and of the whole phenomena of the ſuperficies of the earth, above ground and below, I am obliged to conclude, that there has been an univerſal deluge; but from many of theſe phenomena of nature, which I have carefully inveſtigated; I am alſo obliged to conclude, that this deluge differed in ſome eſſential particulars from what has been imagined and recorded by former writers upon the ſubject. The deluge was not brought about by producing a quantity of water, ſufficient to cover the earth round about, to the depth of ſeve-

ral miles, ſo as to overflow the ſummits of the higheſt mountains, which appears to me impoſſible, without a miracle, if we allow thoſe mountains to ſtand firm and remain as they now are. The univerſal deluge was brought on and accompliſhed by the concurring agency of a number of ſecond cauſes; all of which were prepared and ripened in the ordinary courſe of nature. From there being no rain in the antediluvian earth, the ſuperficies of the ſtrata gradually loſt their coheſion, and approached to decay, for want of natural and neceſſary moiſture. An immenſe quantity of water was accumulated in the regions of the atmoſphere, by conſtant evaporation from the ocean and lakes, without any returns or diminution by heavy rains, during the ſpace of near two thouſand years; but when the rain began, it continued pouring down conſtantly for the ſpace of ſix weeks, if not ſix months. When this conſtant heavy rain poured down upon the over-dried and half calcined ſtrata, the ſudden acceſs of ſuch abundance of water naturally produced an ebullition and ferment, whereby the diſlocation and deſtruction of the ſolid ſurface of the earth was ſoon completed; and by this means, the rocky ſhores, which were then the only mural bounds of the ocean, were decompoſed, broken to pieces, and mixed with the waters of the ocean, and of the rain. When the boundaries of the ocean were thus broken to pieces, and mixed with the waters into a ſort of chaos, the fluid ſurface was ſoon greatly enlarged, and thereby a much greater ſurface of attraction was expoſed to the influence of the Sun and Moon, and of conſequence, the tides would be proportionally raiſed; and this natural cauſe and means, when joined with the conſtant heavy rains, and the diſſolution of the ſuperficies of the ſtrata, would, when all united, ſoon overflow and deſtroy the whole ſolid ſurface of the globe, and produce an univerſal chaos or deluge.

Whether this great event and concluſion of the former earth was wholly accompliſhed by the maturation and concurrence of the ordinary ſecond cauſes alone, or if there was ſuper-added ſome extraordinary and extraneous cauſe, to haſten and augment the operation and effects of the ordinary natural cauſes, I will not determine. Whiſton ſays, that " a comet cutting the plane of the ecliptic, in its deſcent towards its perihelion, on the firſt day of the deluge, paſſed before the body of our earth;" and the ſame learned aſtronomer tells us, that this comet came ſo near to our globe, that the earth paſſed quite through the atmoſphere and tail of that comet, whereby the earth attracted and acquired from the comet a great quantity of watery vapour, which fell down in rain upon the earth. He further tells us, that this comet was about ſix times as big as the Moon, and that it came ſo near to our globe, as, by its attraction, to raiſe the diluvian tides to the extraordinary height of about thirty miles perpendicular. I obſerved before, that Whiſton has not been contradicted, but rather confirmed in theſe calculations, as other aſtronomers own the appearance of ſuch a comet at the preciſe time mentioned by him; but as I am no judge of theſe matters, I will not inſiſt upon this concurring cauſe of the deluge. All, therefore, that I will ſay concerning the comet is this: If ſuch a comet came ſo near the earth at ſuch a time, the neceſſary conſequence muſt be, that its approach would greatly haſten and augment the other natural cauſes of the deluge; which cauſes we have adduced from the natural conſtitution of things before the flood; at the ſame time, the approach and effects of a comet do not appear to me abſolutely neceſſary to produce the deluge. But whether the deluge was occaſioned altogether by the natural cauſes which I have mentioned, or whether ſome extraneous cauſe, like Whiſton's comet, was ſuper-added to haſten and increaſe the effects of the natural cauſes, it appears from Moſes's writings, that the deluge continued at the full height during the ſpace of near half a year. After acquainting us, that "the windows of heaven were opened," by which I underſtand the commencing of the ſix weeks or ſix months diluvian rains, and that " the fountains of the great deep were broken up;" by which I underſtand the breaking and mixing with the waters the rocky ſhores, which were the mural barriers of the ocean,—Moſes tells us, that " the waters prevailed exceedingly upon the earth;" and afterwards, he ſays, that " the waters prevailed upon the earth an hundred and fifty days;" and after the expiry of the hundred and fifty days, we are told, that " God made a wind to paſs over the earth, and the waters aſſuaged. The fountains alſo of the deep, and the windows of heaven were ſtopped, and the rain from heaven was reſtrained. And the Ark reſted upon the mountain of Ararat, in the ſeventh month," which was exactly at the end of ſix months from the firſt day of the deluge.

The ſtopping of the windows of heaven is explained by Moſes, when he ſays, that the rain from heaven was reſtrained. By the fountains of the great deep being ſtopped, I underſtand the forming of our rocks and ſtrata as a new boundary to confine the ocean within its preſent bed.

In Moſes's hiſtory of the deluge, we hear nothing of wind until the height, or a little after the height of the deluge; and then we are told, that " God cauſed a wind to paſs over the earth." The Ark, with man, and all the land animals, was to float upon the waters of the deluge during their progreſs and encreaſe to the height; and in this ſtate of things, as the Ark was the contrivance, the command, and the care of heaven, it would not be expoſed to any real danger from unneceſſary winds or tempeſts. By the ordinary motions of the high diluvian tides, the Ark muſt ſuffer; but it was fully able for theſe agitations, and it was not diſtreſſed with ſtorms of wind. But when the diluvian ſtate of the terraqueous globe was paſt the height, at the end of half a year, from the firſt beginning of it, and the Ark was grounded upon the mountain of Ararat, then, and not till then, we hear of a "wind paſſing over the earth,—of the waters aſſuaging,—of the waters going and returning from off the earth continually,—and of the waters going and decreaſing continually, until the tenth month, when the tops of the mountains were ſeen;—and in the ſecond month, on the ſeven and twentieth day of the month, was the earth dried," which was ſomewhat more than a full year from the commencement of the deluge.

It may be remembered, that I took notice above of the effects and marks of ſtrong winds augmenting the force of the high tides of the deluge, after the higheſt mountains and the elevated plains were formed; the marks of the fury and force of which winds is very evident upon the face of the earth, in diſſevering the iſlands from the main, and from one another, and in ſcooping out the various bays, gulphs, and inlets, which are every where to be found, and which I pointed out above. When I made that curſory ſpeculative ſurvey of the external figure of the dry land, I did not then recollect thoſe words; but I ſaw ſuch evident marks of ſtrong winds attending and urging the high tides, that I was led to ſuppoſe their exiſtence and powerful action and effects; and whoſoever will take the trouble to peruſe what I have ſaid concerning the gulphs and indentings of the ſhores, will ſee the propriety and perfection of Moſes's complete though ſuccinct narrative; and the propriety, though imperfection of my remarks upon the external phenomena of the dry land.

Were I to attempt a recapitulation of all the proofs of an univerſal deluge, I muſt not only repeat all I have advanced in theſe mineral eſſays, but I muſt alſo touch at, and explain the whole natural hiſtory of the ſuperficies of our globe, below ground and above, all of which diſtinctly point at that great event. The few inſtances which I have produced are ſufficient, both in number and force of evidence, to convince the candid naturaliſt of the truth of my propoſitions; and he that wants further proof and illuſtration of the doctrine of the deluge will find it in all the phenomena of the Mineral Kingdom.

VII. *Tracts on ſeveral ſubjects relating to the Mineral Kingdom.*

Of Volcanoes.

The natural hiſtory and the phenomena of volcanoes are extremely myſterious and difficult to be explained, becauſe we cannot deſcend into a volcano to examine circumſtances. However, in a work of this nature, upon the Mineral Kingdom, it would be unpardonable to paſs over volcanoes in ſilence, without communicating ſome of my thoughts upon ſuch a difficult and intereſting ſubject.

I the more willingly enter upon this taſk, as I am in hopes of being able to throw out ſome obſervations which may be of uſe, in future, to mitigate the calamities ſuffered by the miſerable inhabitants of volcanic regions. I fervently commiſerate the dreadful calamities which they have ſo often and ſo lately ſuffered; and nothing would give me greater pleaſure than to be enabled to communicate ſome hints which may be of uſe to prevent ſuch diſmal cataſtrophes in future.

Volcanoes will, in many reſpects, for ever remain awfully myſterious; at the ſame time, there are ſeveral circumſtances relating to them, which may be judged of by analogy.

It is more than probable, that the inflammable matter, which at firſt was the cauſe, and continues to be the feuel of volcanoes, is contained in veins which cut and interſect the bowels of the volcanic mountains and the adjacent plains; and I think it may be ſuggeſted as equally probable, that thoſe veins are of the ſame ſpecies and deſcription as the mineral veins, in which the uſeful metals are found; and if this is allowed, I imagine, that uſeful diſcoveries may be made for the future ſafety of the inhabitants of volcanic neighbourhoods; and, therefore, I will ſuggeſt a few hints for that purpoſe.

There are two kinds or deſcriptions of mineral veins, which are known to trend in a pretty ſtraight line to a conſiderable diſtance. Many of theſe veins have been traced for ſeveral miles. The one of theſe is the perpendicular mineral fiſſure, called by ſome miners a *rake vein*, and the other is the *flat* or dilated vein. Rake veins are found to cut the ſtrata in a direction nearly ſouth and north, and weſt and eaſt. I ſay nearly, for the bearing of the veins is to the eaſt of north, and to the weſt of ſouth; but the ſouth and north veins are commonly found to contain the greateſt quantities of the metallic ores. The flat dilated veins do not cut the ſtrata at all, but are found between two particular beds of ſtone, one of which is immediately above, and the other immediately below the vein; and the vein is contained in the ſpace betwixt theſe two layers or beds of ſtone; of conſequence, the bearing of the flat vein is the ſame as the bearing of the ſtrata, which, in European latitudes, is leſs or more to the eaſt of north and weſt of ſouth. Many of the rake veins are commonly very ſtraight, or cloſe near the ſuperficies of the ſtrata; that is, the ſides of theſe veins are frequently very cloſe together near the ſurface. I have often ſeen them ſo ſtraight for two or three hundred feet down from the ſurface, that the ſides of the veins would not open above three or four inches aſunder in all that depth; and yet, nevertheleſs, they would gradually open further down, to the wideneſs not only of ſeveral feet, but of ſeveral yards; and it is generally in theſe wide concavities of the veins, that the greateſt bodies of the metallic ores are found, and very probably, it is in ſuch receptacles that the greateſt quantities of the volcanic feuel is lodged.

The flat veins found between the ſtrata are not to be inveſtigated upon the ſame principles as the rake veins; nevertheleſs, theſe alſo are frequently very ſtraight or cloſe near the ſuperficies of the ſtrata. The ſpace between the two ſtrata which conſtitute the upper and nether ſide, or roof and ſole (as they may be called,) of this vein, are ſeldom regular, or equidiſtant. In ſome places they come cloſe together, and continue ſo for a leſs or greater ſpace, and in other places or parts of the ſame vein, they open aſunder, and form enormous concavities, which frequently trend in a horizontal direction; and the direction or bearing of ſuch concavities is generally north and ſouth, or between that and the collateral points of north-eaſt and ſouth-weſt.

The eaſt and weſt rake veins interſect thoſe which trend from ſouth to north, nearly at right angles; and they cut the ſtrata in a line nearly right acroſs the bearing, and parallel to the declivity or ſlope. The flat veins ſituated between the ſtrata, likewiſe open into concavities from weſt to eaſt: That is, beſides the concavities in the flat veins mentioned above, which run parallel to the bearing of the ſtrata, there are alſo found in them, concavities which run at right angles acroſs the other, in a line nearly from weſt to eaſt, which comes to be parallel to the line of declivity of the ſtrata; and as that is the caſe, it is eaſy to conceive, that the one end of theſe laſt mentioned cavities point up toward the ſurface, and the other end points ſlanting downwards into the body of the earth, with a degree of ſlope exactly equal to the declivity of the ſtrata in that particular place. I need not here point out the very great variety of the declivity or ſlope of the ſtrata in different places. That point is fully explained in my treatiſe upon the natural hiſtory of coal. I will only obſerve here in general, that the line of the declivity of the ſtrata in different places is found in all the degrees of ſlope between the vertical and horizontal poſitions of the ſtrata. From what has been ſaid concerning the eaſt and weſt concavities of the dilated veins, it will clearly appear, that the eaſt end of each of theſe cavities will gradually dip down under more and more cover, until at laſt they arrive under a prodigious weight and ſtrength of the incumbent ſtrata, even up to many hundred fathoms perpendicular of ſolid rock. There are found ſome rake veins running in collateral lines between the two lines abovementioned; but as theſe are only inferior ſtrings branching off from the capital ſouth and north, and eaſt and weſt veins, they only continue their courſe or line of bearing to a ſhort diſtance from the veins which they branch out of, and then they come to nothing; that is, the ſides of this ſtring, which for a while cut the ſtrata in an oblique or diagonal direction, come cloſe together at a ſhort diſtance from the capital vein, and at laſt ends in a mere crack in the ſtrata; and a little further forward, the ſtrata are found ſolid, without the leaſt ſymptom of any vein in the line of bearing.

From this inveſtigation, it appears, that the capital mineral veins which are found within the ſolid ſuperficies of the earth, trend in a direction a little to the eaſt of north, and to the weſt of ſouth; and that what are called eaſt and weſt veins, are ſeldom found to contain very conſiderable quantities of the metallic ores; and I have no apprehenſion of their containing great quantities of the volcanic feuel. There is a very good natural reaſon for the fruitfulneſs of the north and ſouth veins; that is, for their containing the greateſt quantities of mineral matter, which I have explained in a treatiſe of the natural hiſtory of mineral veins, &c. However, this is not without exceptions. In ſome few mining fields, the eaſt and weſt veins are moſt productive; at preſent we will take it for granted, that the north and ſouth veins contain moſt mineral matter, and let thoſe who are chiefly concerned compare what I advance with experience and matter of fact. From this ſketch of the hiſtory of mineral veins, it appears to me very evident, that the greateſt quantities of the volcanic feuel is lodged within the ſolid ſuperficies of the earth, in veins and receptacles which have nearly ly a north and ſouth bearing, from the mountain or other place where the volcanic fire firſt broke out; and that the volcanic fires and conſequent excavations will advance below ground in the ſame direction. Now, if this is found to be true, we ſhall be enabled to lay down ſuch beacons, cautions, and rules, as will be of general utility for the ſafety of the inhabitants in the neighbourhood of volcanoes. I write only from my own obſervation, and real knowledge of the interior ſtructure of the ſuperficies of our globe; and from my knowledge of the ſtructure, diſpoſition, and bearing of the ſtrata of rock, which compoſe the ſuperficies of the globe in all parts of the world, it appears to me, that the bearing of the ſtrata in the iſland of Sicily, which ſuffers ſo much from volcanoes, ſhould be nearly in a line from S. S. W. to N. N. E. and conſequently, that the bearing of the veins which contain the volcanic feuel, ſhould trend nearly in the ſame line of direction; and I think, that Meſſina, and thoſe parts of Calabria which ſuffer ſo much from earthquakes, are pretty much in this line.

If, upon examination of circumſtances upon the ſpot, it is found, that the ſite of Meſſina, &c. is nearly upon this point of the compaſs from Mount Ætna, or any where between the cardinal point north, and the collateral point northeaſt, and that the volcanic regions of Calabria are in the ſame line, that is, nearly N. N. E. from Ætna, it may be concluded, that my obſervations are founded in truth, and that there is no ſafe ground for founding a city, town, or harbour, any where near that line.

There are certain claſſes or arrangements of ſtrata, of particular characters and qualities, which accompany one another in longitudinal diſtricts upon the face of our globe. Theſe arrangements of concomitant ſtrata are found in patches of leſſer and greater dimenſions; but generally extending further in the line of bearing than in the line which croſſes the ſtrata. In ſome of theſe diſtinguiſhable claſſes of ſtrata, ſeams of pit-coal are moſt frequently found, others produce the greateſt number of lead and copper mines, &c. and it is highly probable, that there are certain arrangements of co-natural ſtrata, in which the greateſt quantities of the volcanic feuel is lodged. This article, in the natural hiſtory of the Mineral Kingdom, deſerves to be carefully examined in volcanic countries.

If it is judged, that the hints which I ſuggeſt upon this ſubject come near the truth, let the intelligent naturaliſt take my book in his hand, and traverſe the neighbourhood of Mount Ætna, and between that mountain and Meſſina, and let him examine the nature, colour, and quality of the ſeveral ſtrata in that line, and likewiſe in the continuation of the ſame line into the volcanic regions of Calabria. I ſuppoſe that much of the ſurface of the ground near Ætna will be covered with lava, aſhes, and other rubbiſh, where the ſtrata cannot be ſeen; however, he will ſee them in ſeveral places in that line, and eſpecially upon the ſhores of Sicily and Calabria. When he has ſatisfied himſelf with reſpect to the quality and characters of the prevailing ſtrata in that line, then let him examine the ſtrata, either inland or along the ſhores of the Mediterranean Sea, wherever he can beſt ſee them in a line from weſt to eaſt, right acroſs the bearing of the ſtrata, which we have ſuppoſed to be about N. N. E. and S. S. W. and when he meets with an arrangement of ſtrata, or rocks of a quite different quality and colour, &c. from thoſe found in the volcanic line, he may conclude, that he is in a place of ſafety for the foundation of a city or harbour, &c. eſpecially if he is far enough eaſt or weſt over the line of the ſuppoſed range of the volcanic ſtrata. The principal crater on the ſummit of Mount Ætna may be ſuppoſed to be the center of the volcanic ground, though that is a little uncertain, as we cannot poſitively determine whether the veins and excavations of that mountain deep down have advanced fartheſt towards the eaſt or weſt: However, perhaps, we can fix upon no better point than the great crater, from whence to draw the line towards Meſſina and Calabria. If the ſuperficies of the ſtrata about the foot of the mountain could be ſeen for lava and other volcanic rubbiſh, the naturaliſt could gueſs pretty nearly what is the breadth of the volcanic ground in the iſland of Sicily; but as I ſuppoſe he cannot ſee the ſtrata about the mountain, he muſt be the more careful to inveſtigate circumſtances upon the ſea ſhores, the banks of rivers, and other places near Meſſina, and in Calabria, where the ſuperficies of the ſtrata are to be ſeen; and when the beſt judges of theſe matters have acquired ſufficient degrees of knowledge of the diſtinguiſhable characteriſtic qualities of the ſtrata of the volcanic region, to be enabled to form a ſafe and prudent plan for the ſite of ſea-ports and cities, far enough from dangerous ground, then let Meſſina, and all the regions in Sicily and Calabria which have ſuffered, and are in moſt danger of ſuffering ſuch dreadful and deſtructive ravages from the earthquakes and volcanic eruptions, be abandoned by the generality of the people, and adapted to huſbandry only, which requires but few people to inhabit thoſe places, who can eaſily remove for a while in time of danger, and the huſbandmen may be inſtructed, from time to time, which way to fly in time of danger, in a right direction, to places of ſafety; that is, to fly off the line of the volcanic ground, to places which ſuffer leaſt from theſe calamities. I cannot help conſidering it as preſumptuous, and in the higheſt degree dangerous, to think of living in Meſſina, or any other of the towns or harbours in Sicily or Calabria, which have recently, or at any former period ſuffered by earthquakes and eruptions; becauſe the ſame places are in continual danger of ſuffering the ſame over and over again, and every ſucceeding ſhock ſhould be worſe or more dangerous than the former; becauſe the rocky cruſt which lies above the volcanic excavations, and under ſuch town, harbour, or other place, is greatly weakened by being ſhaken, rent, and ſhattered with former ſhocks, and there are only two chances in nature that can ever make thoſe places ſafe for the habitation of man. The one of theſe chances reſts upon the ſuppoſition, that the whole magazine of the volcanic feuel in that region may be entirely exhauſted, of which we can ſay nothing, as we cannot ſurvey thoſe magazines to enable us to judge of their extent and duration. The other chance is, that an earthquake or volcanic eruption ſhould open ſuch a breach in the bed of the ſea, as to make room for the ocean to ruſh down in ſuch a vaſt body as ſuddenly to fill up the excavated receptacles of the volcano, which muſt ſoon extinguiſh it altogether; but both theſe chances are too diſtant and uncertain ever to be truſted. It muſt happen, that ſeveral repeated volcanic concuſſions dry up many ſprings and rivulets, by which a great quantity of water is let down into the excavations of the volcano; but ſuch comparatively ſmall quantities of water have a direct tendency to aggravate the evil, and to make the volcano ten times more dreadful and miſchievous, as every drop of that water is evaporated and reduced to highly rarified ſteam, by the prodigious heat of the fiery caverns of the volcano; and the experience we have of the ſteam engine enables us to form ſome idea of the prodigious force of ſteam, when it is greatly heated and confined within limited bounds.

When a copious ſtream of the atmoſphere gets acceſs into a volcano, and, by its denſity and weight, ruſhes into the remote excavations, and gets under or behind extenſive clouds of ſteam, the conſequences muſt then be dreadful. The expanſion of the ſteam, before the external air is ſo copiouſly admitted, fills all the volcanic ſpaces; but the coolneſs of the air in part condenſes the ſteam, which makes room for ſtill greater quantities of air to ruſh in; but when the ſteam is again fully expanded, and the admitted air highly rarified by the exceſſive heat of the volcano, the united force of both is ſufficient to convulſe the whole globe, and to rend aſunder the ſtrongeſt bars of the earth, if it does not find a thin enough cruſt of rock through which to burſt a paſſage. What are the exploſions of gun-powder, and any force of ſteam which we can bring to act, but trifling experiments, and children's play, in compariſon of theſe mighty operations and effects. It is only in the volcano that they act like the great works of nature. When ſufficient quantities of theſe powerful agents get behind melted and unmelted matter within the receptacles of the volcano, and are fully rarified, when the exploſion happens, if the vent is wide enough, it will drive out every thing before it through the mouth of the crater: But if the paſſage is too ſtraight, or is obſtructed by falls of the rock within, by congealed lava, or otherwiſe, in that caſe, it muſt and will burſt up the rock, and make a new vent or paſſage, as it happened lately in Sicily and Calabria.

From all theſe conſiderations, when viewed jointly and ſeparately, there appears no place of permanent ſafety within the line and limits of the volcanic feuel, which I wiſh to be able to point out, and which I hope will in time be found and underſtood; and as there is no permanent ſafety, neither is there any poſſibility of knowing when or where the earth may be convulſed and rent again and again within the old volcanic limits; nor is it eaſy to judge how far the ſubterranean fires may advance in the line of bearing, which we have ſuppoſed to be in Sicily and Calabria about N. N. E. and S. S. W.

Theſe hints are well intended. They flow from a fervent deſire of doing good. Let them not be raſhly condemned without examination and a fair trial. They may not be readily underſtood by every body; however, they are all founded either in experience, or upon ſolid principles; and, therefore, they deſerve to be ſeriouſly and thoroughly inveſtigated; and, perhaps, theſe hints being thrown out by a plain practical man, may be the means of ſuggeſting to naturaliſts ſuch further diſcoveries and improvements as will conduce to the ſafety and happineſs of the inhabitants of Sicily, and all other volcanic countries. For if proper rules can be laid down for the ſafety of one country that is diſturbed by volcanoes, upon the principles of mineral philoſophy, it is to be ſuppoſed, that the ſame rules will hold good every where, making proper allowances for the different bearings of the ſtrata in different latitudes. Now, the bearing of the ſtrata at the equator muſt be true ſouth and north; and as we recede from the equatorial regions towards the northern tropic, the bearing of the ſtrata inclines gradually towards the eaſt of north; and as we advance from the tropics towards the north-pole, the bearing of the ſtrata inclines gradually more and more, until at laſt it comes to be north-eaſt, and they trend gradually towards the eaſt to the ſouth of the equator, in like manner as to the north.

It may be proper to obſerve here, that, in ſome particular circumſtances, the ſtrata in a ſmall ſpot or diſtrict may, and do vary and deviate from the true general line of bearing; as, for inſtance, when the ſtrata lie exceeding flat in the horizontal poſition, they are in that caſe found to wave up and down, and to dip this way and that; and while they continue thus to wave up and down, they acquire many different bearings and ſlopes, frequently towards all points of the compaſs. But this accident is not of any great continuance. It only happens upon a ſmall ſcale, and in a ſmall diſtrict, but does not in general affect nor alter the true line of bearing. The different bearings and declivities of the ſtrata, with the natural reaſons or cauſes of that diverſity, has been fully inveſtigated and explained in a former part of this work, to which I refer. With reſpect to our preſent enquiries, it is proper to take it for granted, and naturaliſts viewing circumſtances will find that I am right, and they can improve upon my hints, ſo as to become maſters of the natural hiſtory of the ſtrata in the neighbourhood of the volcanoes which they are acquainted with, and they will thereby be enabled to make uſeful communications to the world; and if they will read my Natural Hiſtory of the Strata of Coal, and my obſervations about the ſtratification of the ſuperficies of the globe, they will find ſuch aſſiſtance, in acquiring the knowledge of the conſtruction of the ſolid ſuperficies of the globe, as will make their inveſtigations eaſy, pleaſant, and ſucceſsful. In the mean time, allow me to aſk, how they can be better employed, than in attempting to be able to point out ſuch rules and cautions for the future ſafety of ſuch numbers of our brethren as are ſtill expoſed to thoſe dreadful calamities, which have ſwallowed up and deſtroyed thouſands in all parts of the world that are infeſted with volcanoes?

By theſe enquiries and inveſtigations, naturaliſts may become the miniſters of health and ſafety to numbers of mankind; and how can they attain greater honour or happineſs! And what ſignifies the idle ſelfiſh pomp of learning and knowledge, if it is not exerted for the good of the world?

I will add, in this place, a ſtrong argument to enforce the examination of this ſubject, which is this: We find, in experience, that the Almighty ſeldom or never ſends a great calamity to ſcourge the children of men, but he alſo, at the ſame time, points out, or puts in our power an antidote or means which wiſdom and caution may lay hold of, and uſe to mitigate the ſeverity or extreme rigour of ſuch calamity.

A great many examples of this might be given to ſhew, that the Alwiſe Governor of the world, in the midſt of judgment, remembers mercy, and puts the means of deliverance or of mitigation in the power of prudence and exertion; but I will only point at one inſtance, viz. the ſmall-pox, as one of the ſevereſt ſcourges of the human race.

In ſome countries it ſweeps away whole tribes at once, and in almoſt all places, prodigious numbers are deſtroyed by this loathſome malady; but now, and even long ago, Providence pointed out inoculation, as not only a happy means of mitigating the rigorous and deſtructive ſeverity of this dreadful malady, but in a great meaſure as a perfect antidote; for many phyſicians in Britain have inoculated thouſands without hardly loſing one, and almoſt without leaving a ſingle mark of their patient's ever having had the ſmall-pox; whereas the few who eſcape with life, when ſmitten in the natural way, without being inoculated, find blindneſs and deformity are but too commonly entailed upon them as long as they live.

It was a long time before inoculation prevailed among us in all parts of Britain. I wiſh to God, that now, when philoſophy and ſcience are arrived at ſuch degrees of perfection in Europe, and now that earthquakes and volcanic eruptions are become ſo common, and ſo very deſtructive in many parts of the world, that proper means to mitigate and to ſhun the diſmal effects of this calamitous ſcourge could be found out, and ſure rules formed for the future ſafety of the inhabitants of thoſe countries. I think this attainment not only poſſible, but alſo practicable; and this perſuaſion is not only founded upon a fervent deſire that the above hints may anſwer the deſign for which they are written, but is alſo founded upon the equal, wiſe and benevolent providence of God, who never ſends a ſcourge, and permits a ſevere evil to viſit mankind, but he alſo ſends the means of eſcaping, or at leaſt of mitigating that evil; but many of theſe means require wiſe and ſtrenuous exertions, and too many of us are like negligent ſailors, who forget, when one ſtorm is over, that they are ſtill in danger, but content themſelves in their preſent ſafety, and never think of putting their ſhip in proper trim for weathering the next ſtorm, until it overtakes them unprepared.

It is ſaid, that neceſſity is the mother of invention, and I hope, that the great and preſſing neceſſity of this caſe, will prompt thoſe who are chiefly concerned to attempt the remedy, or at leaſt the mitigation of this great evil; and there appears to me no ſure remedy in nature, or, in other words, no ſure means of mitigating this evil effectually, but for the bulk of the inhabitants of ſuch countries to ſhun the line of the volcanic ground, and to leave thoſe dangerous ſituations, where ſo many of their brethren have periſhed in a moment, to be occupied by farmers only, who ſhould live in tents, or in other ſlight habitations, which could not cruſh them by their fall, and which would be eaſily reared up again when thrown down by the concuſſions of earthquakes; and theſe farmers ſhould be inſtructed which way to fly from danger to ſafer ground; and, moreover, they ſhould be well inſtructed to underſtand and obſerve the ſigns and ſymptoms of approaching danger, that they may always have it in their power to provide for their ſafety by flight. I have no manner of doubt of there being external ſigns and appearances, and interior ſymptoms and warnings of approaching danger, which will be almoſt infallible when well underſtood and well attended to. There will be appearances in the clouds, which the peaſants can eaſily be inſtructed to obſerve, and no doubt the atmoſphere will be in a changeable imperfect ſtate before an earthquake. In ſhort, whatever the peaſants can ſee and hear as warnings of danger, they can be eaſily inſtructed in the knowledge of; and it is the province of intelligent naturaliſts to inveſtigate the cauſes of effects, and the effects of cauſes. It has been obſerved in many parts of the world, that the atmoſphere is uncommonly agitated, and in an imperfect ſtate, all round the globe, before any great earthquake. And it is ſaid, that rumbling noiſes are heard under ground in volcanoes for ſome days before a great earthquake and eruption. Perhaps part of the cauſe of theſe ſubterraneous noiſes may be occaſioned by copious ſtreams of air and ſteam ruſhing out when violently heated through paſſages, which are yet pretty clear and open; but that, during this time, ſtreams of lava are propelled forward from remote parts or excavations of the volcano; but when this mighty ſtream of lava accumulates in a ſtraight mine or paſſage, then the cataſtrophe is near. The mighty guſts of volcanic reſpiration are at an end; but there is a quantity of air and ſteam behind the lava, which is increaſing rapidly by the continual ſupply of water from a thouſand vents, which is ſuddenly converted to ſteam; and when this ſteam is ſufficiently heated, then an earthquake enſues, and the lava is either propelled to the ſurface by ſome of the old apertures, or new breaches are made where the rock is weak, as happened lately in Sicily and Calabria. Now, if we allow of this ſuppoſed violent reſpiration of the volcano, for a few days before the earthquakes and eruptions, it will ſufficiently account for the uncommon agitation and imperfect ſtate of the atmoſphere in all parts of the world.

I obſerved above, and it is well known, that many ſprings and rivers are dried up by volcanoes, and all the rain and ſnow which falls upon volcanic ground, muſt all find its way down into the ſubterraneous excavations, excepting what is immediately evaporated upon the ſurface, and no doubt much more water goes down into volcanoes than we can eaſily imagine, and eſpecially when in their progreſs, they advance under rivers, rivulets, lakes, and ſome of them even under the ſea itſelf. Now, what becomes of the prodigious quantities of water that percollates the pores and cranies of the ſtrata, and that ruſhes down through the natural and accidental cracks and fiſſures of ſuch extenſive rocks as cover, and are ſituated upon both ſides of ſome ancient volcanoes? Every drop of it is diſſolved and converted into ſteam by the prodigious heat of the volcano. Now, a prodigious quantity of water, evaporated into ſteam by ſuch a heat as that of the volcano, will ſoon fill all the excavations of the volcano like a thick cloud; and while this vapour is fed by continual and copious ſupplies from the feeders of water, and the extraordinary heat, the ſteam will ſo effectually fill all the receptacles of volcanoes, as to exclude and prevent the admiſſion of the external air into any of thoſe receptacles.

I muſt not be underſtood to mean, that the external air is abſolutely excluded from every part of the volcano. The fire could not exiſt without a communication of leſs or more of the external air; and the extreme degree of cold which gentlemen who viſit volcanoes have found in ſome narrow caves and paſſages in the ſides of volcanic mountains, is a clear proof of the air ruſhing violently through thoſe fiſſures to fan and feed the fires below; but what I mean is this, that the great heat, with a thick and ſtrong cloud of ſteam, will fill all the great excavations of the volcano, and effectually exclude the external air from entering through the crater; nor can it poſſibly get admiſſion into thoſe receptacles thro' the crater and common main paſſage, while the heat and ſteam continues in full force.

Theſe hints are not merely conjectural. They are founded upon obſervation and analogy, in comparing great things with ſmall, which is the ſureſt way of coming at the truth in ſuch abſtruſe diſquiſitions as theſe. Steam from boiling water raiſed by great heat, and confined within any veſſel or cloſe receptacle, is far ſtronger and more powerful than the weight of the atmoſphere. This is a fact very well known, and now clearly proved by Mr Watt's ſteam engine. The ſpecific gravity or weight of the atmoſphere, when preſſing upon any ſurface above a vacuum, is upwards of fourteen pounds avoirdupois upon every ſquare inch; but it is now found, and clearly demonſtrated, by Mr Watt's ſteam engine, that the force of ſteam is much greater than the ſpecific gravity of the atmoſphere, ſo as, when confined, to preſs upon a ſurface with a force conſiderably upwards of twenty pounds upon every ſquare inch. This fact is very well known, and daily experienced in working Mr Watt's improved engine; and moreover, we ſee this fact continually exemplified by obſerving the ſteam iſſuing out, when the ſteam clack or valve upon the top of an engine boiler is opened. When this valve is firſt opened, the ſteam ruſhes out with a force and noiſe proportioned to the ſize of the boiler, and the degree of heat the fire is raiſed to below, and it continues to ruſh out with violent force for ſome time; however, by and by, when no more feuel is caſt into the furnace, and the fury of the heat below the boiler is abated, the ruſhing noiſe of the ſteam ceaſes; and when we look at the valve, we ſee that no ſteam iſſues out for the ſpace of about two or three minutes; but in a little while we hear the roaring of the ſteam again as loud as at the firſt, and we ſee as copious a ſtream or cloud of it ruſhing out as when the valve was firſt lifted; however, it does not laſt ſo long as at firſt before it ceaſes again, and theſe alternations continue in ſome degree until the heat below is ſo far abated as to raiſe but little ſteam in the boiler, tho' the guſts of ſteam iſſuing out grow weaker and weaker each time. The phenomenon of the roar and force of the ſteam ceaſing, and being renewed again alternately, attracted my curioſity, and engaged my attention to examine the cauſe; and I ſoon found, that it could be no other than the admiſſion of a quantity of the external air into the boiler through the valve, and that air, by its gravity, ruſhing down beneath a quantity of ſteam. This admitted air, by its coolneſs, will in part condenſe the ſteam it comes in contact with in the boiler, which will make room for more air; but when the ſteam is again dilated to its former ſtate, and the admitted air is rarified by the heat of the boiler, both ruſh out again with renewed force and noiſe. Now, it is obſervable, that for a few minutes after the valve is lifted, the ſteam ruſhes out conſtantly with force and noiſe, for during this ſpace of time, the force and power of the ſteam exceeds the force or weight of the atmoſphere; and therefore, the external air is perfectly excluded from entering the boiler while the ſteam continues in ſuch force; but when the heat under and within the boiler is ſo far diminiſhed, as to bring the ſteam within the boiler in equilibrio with the weight of the atmoſphere, in a little time the air gets the better of the ſteam, and ruſhes copiouſly down into the boiler, through the ſame vent as the ſteam before ruſhed out; and while the air is ruſhing down through the aperture of the valve, the noiſe ceaſes, and no ſteam iſſues out; nor is there any more appearance of ſteam about the valve for a few minutes than if the boiler was cold and empty; but when the ſteam is again ſufficiently heated, and the admitted air rarified, the external air is again conquered by a ſuperior force, and the ſteam ruſhes out again with force and noiſe; and ſo on alternately, until the water in the boiler is ſo much cooled, as not to be in force to exclude the atmoſphere at all. We may call this the reſpiration of the boiler; and if we will ſuppoſe ſuch a reſpiration in the volcano, and conſider the different ſcale of the receptacles of the ſteam, we need not wonder if the atmoſphere is uncommonly agitated ſome days before a great earthquake. We do not know, nor can we pretend to explain, what effects the colliſion of a copious ſtream of atmoſpherical air may have, when ruſhing in and paſſing over the ſurface of an extended flood of boiling lava, in generating electrical fire, and in producing an electrical ſhock proportioned to the nature of the place and the quantity of the materials; which ſhock may contribute its ſhare with the other volcanic powers to produce mighty earthquakes.

There is an inflammable vapour found in ſome coal mines and other places in the bowels of the earth, which often collects in ſuch remote mines and other parts of the works as are ſcarce of air; that is, where there is not a ſufficient current of air to diſſipate and carry off this mephitic vapour. When this inflammable vapour collects and condenſes in the cool receſſes of remote mines, or other parts of the works, though ſeveral hundred yards from the bottom of the ſhaft, if touched with a lighted candle, it inſtantly takes fire, and goes off with an exploſion like gun-powder, and with a force perhaps ſuperior to it, which often ſcorches and kills the perſons who happen to be near it; and it has frequently been known to ſweep every thing in its way to the ſhaft, and to ruſh up the ſhaft or pit with ſuch force and violence as to carry every thing in its way, and the whole apparatus of the ſhaft, high up into the air. Sparks of fire ſtruck from ſteel and pyrites does not ignite this vapour; and therefore, miners often work in it by the light of ſparks raiſed by a ſteel mill from pyrites, where they dare not uſe a lighted candle.

Now, here is another powerful agent found below ground, which, for any thing we know to the contrary, may be joined with other volcanic forces; and when ſuch a ſmall quantity of this vapour as is contained within the ſpace of a few cubical feet, and a ſmall quantity of gun-powder, when properly confined, are capable of doing ſuch miſchief, and of proving ſo powerful, what may we not ſuppoſe the united force of the volcanic powers capable of doing, when they are in ſuch immenſe quantities, and excited by ſuch prodigious fires in the extenſive caverns of volcanoes? But here all computation and even conjecture fails. We are not capable of forming a proper judgment of theſe ſtupendous and aſtoniſhing ſecret operations of nature. All we can do in ſuch caſes as theſe, is to have recourſe to the effects to enable us to judge of the cauſe.

There is yet another very powerful agent in nature, which is pretty well known, though not ſo well underſtood; I mean electricity, and electricity is the action of fire. If we attentively examine this matter, we ſhall ſoon diſcover that fire is the moſt active, and I believe I may venture to ſay, the moſt powerful agent in nature. Before we attempt to apply the force or operations of electricity to any of the phenomena or accidents of earthquakes and volcanic eruptions, it may be proper to make a few obſervations concerning the nature and properties of fire.

Moſt of the philoſophers of all ages have told us, that the groſs matter of our ſyſtem of things is compoſed of four ſimple elements, viz. Fire, Air, Earth, and Water. Of theſe ſuppoſed four elements, I can find but three, namely, Fire, Water, and Earth; the air or atmoſphere being a mixture or combination of the finer particles of all the three elements of Fire, Water, and Earth: Of theſe three elements, fire ſeems to be the only material principle of activity, life, motion and force in the univerſe. The other two elements are naturally dead and inert, and incline to abſolute reſt. Fire, on the contrary, is all activity, power, and progreſſive motion, when in any degree of liberty, from too cloſe a confinement and union with the other elements of earth and water. The rays of the elementary fire dart from the Sun to our globe, with ſufficient force and velocity to cut their way through an unclouded atmoſphere, until they reach the ſurface of the globe, and then aſcend again ſlowly, mixed with the watery vapour which they produce by reſolution. Theſe rays of fire, emitted by the Sun, or moved by him, daſh againſt the ſurface of our globe, and of all bodies upon it, with a degree of force and violence equal to the velocity of the motion; and as all parts of the ſurface of the globe, and of all bodies animate and inanimate, have ſome degree of humidity, the violent colliſion of the rays of fire melt and diſſolve ſome part of this humidity into ſteam or vapour; in which humid ſteam the pure elementary fire is abſorbed, mixed and united ſo effectually, that it aſcends up into the atmoſphere involved in the watery vapour. This is in ſome meaſure evident to our ſenſes. After a warm ſhower of rain in a ſunny day, we often ſee a thick and copious vapour of ſteam riſing and aſcending from new plowed land, from green banks, and many other parts of the ſurface of the earth; which is a clear and ocular proof of the great quantities of water which the rays of the Sun melt and diſſolve in warm weather. Every motion of the atmoſphere upon the ſurface of the earth, and upon the ſurfaces of all bodies, melts and diſſolves a quantity of the humidity it comes in contact with, in proportion to the violent colliſion of its motion.

In ſtrong winds, vaſt quantities of moiſture is carried up into the air, from the ſurfaces of the land and water, &c. This is evident to our ſenſes, by the ſudden drying of the ſurface of the earth. The quantity of water which is diſſolved and evaporated by the contact and colliſion of the element of fire, and carried up in any given time, is ſo immenſe, that the lakes and rivers, and even the ocean itſelf, would be ſoon exhauſted, and the quantity accumulated over head in the regions of the atmoſphere, would ſoon involve our globe in darkneſs and deſtruction, was it not continually ſeparated from the fire which carried it up, and let fall down again in rain and ſnow, &c. and on the other hand, if the atmoſphere was not continually ſupplied, renewed, and refreſhed, by plentiful humid cooling vapours from the ſurface of the globe, the air itſelf, and the whole ſurface of the earth, would be ſoon burnt up, by the ardent and powerful action of the element of fire. Thus, we ſee, that the ordinary operations of nature have a continual tendency to ſurcharge the air with too much moiſture; but the watery vapour carried up into the atmoſphere, is in part ſeparated from the fire which was united with it, and gave it that expanſion and levity, by many ways either altogether unknown, or very imperfectly comprehended by us. I will not attempt any particular explanation of a ſubject ſo much out of my ſight; however, we may venture to ſay in general, that any increaſed degrees of heat or cold in the regions of the atmoſphere,—every colliſion of the clouds, and every briſk motion of the atmoſphere, releaſes much fire from the watery vapour, by the colliſion and attrition of the parts of the atmoſphere in motion; and of courſe, much watery vapour is at the ſame time releaſed or condenſed. Sometimes the ſeparation of the latent fire from the clouds and atmoſphere, is in ſuch great and increaſed quantity as to become viſible; as, for inſtance, in ſhooting ſtars, or other fiery meteors, which are ſeen in a clear night, in lightning, and the aurora borealis. The aurora borealis, which has puzzled philoſophers for ages, is eaſily accounted for, upon this hypotheſis.

If once we are convinced that our atmoſphere is compoſed of fire, water and earth, and that there is ſuch a reciprocal, progreſſive, or rapid interchange of the union and decompoſition of theſe elements, as we endeavour to eſtabliſh, the phenomenon of the aurora borealis will become of eaſy ſolution, and almoſt evident to our ſenſes.

Every accelerated motion of the atmoſphere, or of any accumulated vapour, has a tendency by violent attrition to diſengage the fire from the watery vapour. In the aurora borealis, we evidently ſee a thin cloudy vapour in violent motion; or we ſee the corruſcations and light of ſtreams of fire, which fire is copiouſly diſcharging from the atmoſphere, and is flying upwards, which may be called a vertical wind. But of all the cauſes in nature of the decompoſition and ſeparation of the fire of the atmoſphere, its approach to a burning fire, or to any great and violent heat, is the moſt powerful and haſty. It is very well known, that a current of air is neceſſary to fan and feed our burning fires; but it is not quite ſo generally known, that in this operation of nature, there is a decompoſition of the texture of the atmoſphere; and that, when the air approaches the heat of the fire, the watery part of it flies back, and the latent elementary fire of the atmoſphere ruſhes forward, and, by its colliſion, diſſolves the viſcid teguments, which contain the latent fire of the feuel, and when both are copiouſly releaſed, the ſenſible heat is proportionally encreaſed.

That the atmoſphere is plentifully mixed with latent elementary fire, is evident from its being procured ſeveral ways by attrition, as in artificial electricity, the friction of dry axles, the peg and board, &c. Now, when a copious ſtream of the atmoſphere enters the mouth of the crater of a volcano, the heat of this prodigious furnace will cauſe the watery parts of the air to fly back; but the latent fire will ruſh forward to join its native element in the excavations of the volcano, and a vaſt encreaſe of the elementary fire from the atmoſphere will ſoon bring matters to a height, and produce dreadful earthquakes and eruptions.

Fire in one ſtate, condition, or modification, or other, ſeems to be the moſt powerful and univerſally active principle and agent in nature. I do not know but it is the only active principle, and natural cauſe of force and motion in the univerſe.

It is fire that thunders in the clouds, and roars in the winds, and tears up the ſuperficies of the earth in hurricanes, and undoubtedly it is fire that rends the rocks aſunder, and ſhakes the foundations of the ſolid globe in earthquakes.

And it is the different mixtures, modifications, conditions, and motions of this element that produce all the mild, beneficial, and ſalutary operations of nature. It is fire that ſuſtains the life, and promotes the growth of plants and animals; it moves gently in our mild ſalubrious fluids, and effervefces more fiercely in many hot and pungent liquids. In ſhort, fire ſeems to be the only active principle in every fluid, and in every moving body; and we can ſet no bounds to the power of this mighty agent.

I could make but little by further attempts to explain and illuſtrate the inexplicable operations of volcanoes; and as I think that I have now ſuggeſted ſufficient hints to throw ſuch gleams of light upon this naturally dark and difficult ſubject as may be of uſe to real philoſophers, I will ſay no more upon this topic at preſent.

All theſe reflections authoriſe us to conclude, that dreadful earthquakes and eruptions will frequently happen ſomewhere in the line of old volcanoes; and it is impoſſible to know when or where they will be moſt violent and deſtructive in that line.

What I mean by the line of the volcanic ground has been pretty fully explained above, where it was obſerved, that the ſeveral ſpecies of mineral veins, which are found by experience to contain the greateſt quantities of mineral matter, run in a line parallel to the bearing of the ſtrata. This point being conſidered as an eſtabliſhed fact, it will follow of conſequence, that whether the volcanic feuel is chiefly contained in veins or in ſtrata, in rake veins, or in flat dilated veins, which are ſituated between the ſtrata, it will run in the ſame longitudinal line of bearing. I have ſome reaſons for being perſuaded, that the inflammable matter, which is the feuel of the volcanic fires, is not contained in ſtrata properly ſo called; though it may, and I am perſuaded that it frequently is contained in the flat veins ſituated between the ſtrata, which were deſcribed above. One reaſon for my rejecting regular ſtrata of volcanic feuel is this: It is well known, that in the conſtructure of the ſtratified parts of the ſuperficies of our globe, the one ſide, or the one edge of the ſeveral ſtrata come quite up to the ſuperficies of the ſolid part of the globe, tho' earth, clay, gravel, ſand, &c. is frequently found of various depths lying above the ſuperficies of the ſolid ſtrata.

In this view of the ſubject it appears, that the one ſide or edge of every ſtratum comes up to the ſuperficies of the ſolids; and therefore, if the volcanic feuel was contained in regular ſtrata, it would follow, that when a volcano was once kindled, it would burn forward in a line quite up to the ſurface of the ground, which indeed would make that line a little troubleſome; but as the volcano by this means would have regular breathing places, as we may call it, by communicating with the ſurface every where as it advanced in the line of bearing, few or none of the dreadful accidents attending volcanoes, ſuch as earthquakes and eruptions, would happen. This we know by experience, as far as analogy will reach.

Seams of pit-coal are regular ſtrata. They are ſometimes ſet on fire by accident, and burn below ground for ſeveral miles. Now, this conflagration not only burns quite up to the ſuperficies of the ſolid ſtrata, but it alſo burns ſuch earth, clay, &c. as lie immediately above the ſolids in the line of bearing, and the ſeveral ſubſtances which come in contact with the fire at or near the ſurface, in the line of the crop or baſſet of the coal, are frequently vitrified, and run together in vaſt maſſes of ſlags reſembling lava; but neither earthquakes nor eruptions ever happen from theſe ſubterraneous conflagrations, no doubt for the reaſon I gave above, viz. becauſe this ſubterraneous burning communicates with the ſurface all along the line of the baſſet of the coal as it advances; and, therefore, the evaporation of the water which goes down, and the rarification of the air that fans the fire continually, find an eaſy paſſage to the ſurface. This is a pretty good example to enable us to judge of theſe matters by analogy.

It has been obſerved, that mineral veins are frequently checked at the ſurface, the two ſides of the vein being ſqueezed cloſe together above; but beſides this cauſe of preventing the reſpiration of the volcanic fires, ſtrata of different qualities may be ſpread over the baſſets, vertex, or tops of the mineral veins in the valleys, which do not reach up to the ſite of the firſt craters upon the mountains. Strata of pit-coal, and their concomitants, are found in valleys, which do not aſcend the high mountains of the coal countries. Veins of volcanic feuel baſſet out in the ſummits of high mountains, where they are firſt ignited; but when they burn down towards the baſes of the mountains, theſe veins may be covered by other horizontal ſtrata, containing no ſuch veins nor feuel.

Mineral veins, whether vertical or horizontal, are exceedingly unequal in their capacities in different places of the ſame vein, frequently opening out to vaſt and ſpacious concavities, and again contracting at a ſmall diſtance into narrower bounds. Now, it is reaſonable to ſuppoſe, that the capacious receptacles of theſe veins contain the volcanic feuel; and that, when the combuſtible matter is conſumed out of theſe cavernous receptacles, they will be greatly enlarged by the vitrification and decompoſition of vaſt quantities of ſuch matter that is not combuſtible, as comes in contact with the prodigious fires and heat of the volcano; and it is as reaſonable to ſuppoſe, that it is in theſe enormous caverns of fire that the cauſes of earthquakes and eruptions are generated. We cannot tell how deep or how far below ground theſe prodigious excavations may reach; but we know, that they can have no communication with the external air, but by the craters, or other apertures which the ſeveral earthquakes have made; and, therefore, no reſpiration nor perſpiration of the ſteam and rarified air, can poſſibly happen here, as in the conflagration of a ſtratum of coal. It muſt either iſſue at the common apertures, or burſt a new paſſage elſewhere; and fatal experience makes it but too evident, that it frequently does burſt a new paſſage in great and deſtructive earthquakes, as happened lately in Sicily and Calabria.

Although the mineral veins, ſuppoſed to contain volcanic feuel, are very unequal in the capacity or dimenſions of the concavities, they are nevertheleſs pretty regular in the line of bearing. I hinted before, that ſeveral veins run parallel to one another in mineral ground, and no doubt this will happen in volcanic ground. In ſome mining fields we meet with ſhort veins, which cut right acroſs between two capital parallel veins, and tack them together without croſſing them, like a croſs road, which leads in a right line acroſs between two parallel roads, and joins them together, but goes no further. Theſe ſhort croſs veins are frequently well repleniſhed with the mineral ores; and ſo they may with inflammable matter in volcanic countries; and if ſo, then the fire will eaſily communicate from one parallel vein to another. I hinted before, that many of the ſtrongeſt and moſt productive mineral veins are piped; that is, are formed into long and high concavities, which run parallel to one another; and theſe pipes frequently point downwards in a ſlanting direction into the body of the earth.

Theſe pipes reſemble a number of long vaults, or arched cells, arranged parallel to one another, only not ſo regular. It is impoſſible for us to know how deep the veins and theſe pipes in them ſtrike down into the body of the earth, whether the veins dip down precipitately, or with an eaſy gentle ſlope; and, therefore, it is impoſſible for us to know how deep the volcanic fire may penetrate; but this one thing, however, we may aſſure ourſelves of, viz. that the deeper and more extenſive the ſubterraneous excavations are, the more dangerous the volcano, and the more miſchievous and extenſive its effects; and the reaſon is obvious, viz. becauſe the deeper and more extenſive the excavations are, the more room there is for the reception of ſteam, air, &c. the which, with the agency of the volcanic fires, I have proved to be the efficient cauſe of earthquakes and eruptions.

It cannot be denied, that the excavations of old volcanoes are amazingly extenſive.

The immenſe quantities of lava, and other matter ejected out of them, proves this to a demonſtration; and, therefore, it may be a query with ſome, how it happens, that the ground above theſe extenſive excavations does not give way and fall in, not only around or near the original crater, but even every where in the courſe or line of the progreſs of the ſubterraneous fires, and produce numberleſs gulphs and chaſms both dangerous and frightful to behold?—I anſwer, if the volcanic feuel was generally contained in regular ſtrata, the earth would ſo fall in, becauſe the combuſtible ſtratum or ſtrata being conſumed from under thoſe immediately above them, the ſuperincumbent ſtrata would infallibly fall down when undermined to a vaſt breadth and length; and this muſt happen in the whole length of the volcanic excavations, and as far in breadth as they are undermined below: But this not being the caſe, is another ſtrong proof, that the feuel is lodged in mineral veins, which not only ſtrike down deep into the earth, but are alſo frequently of a piped form, as we hinted before, which pipes ſometimes ſtand nearly perpendicular, or with a conſiderable ſlope; and, therefore, every part of the intervening rock which ſeparates the pipes from one another, and which ſeparates the ſeveral veins from one another, ſtands as a ſure ſubſtantial pillar fixed upon its own baſe; and it is known by obſervation and experience, that the concavities of mineral veins more frequently expand or open out deep down than near the ſuperficies of the ſtrata. Many of the cavernous excavations of volcanoes will therefore, according to this piped form of the veins, be exceeding wide deep down, and exceedingly capacious; but they will aſſume an arched figure, with, in many places, a thick and ſtrong cruſt of rock above the arched excavations, which does not contain any combuſtible matter.

The natural hiſtory of the ſolid ſuperficies of the globe is a ſubject of difficult inveſtigation; and there are but few, even of our philoſophers and naturaliſts, who are well acquainted with its conſtructure, which makes it the more neceſſary for me to be minute and circumſtantial in explaining ſome particulars. In the practice of mining, we ſometimes meet with what may be called accumulated or concentrated veins; that is, a number of veins or mineral fiſſures, containing rich ores, the one end of which converge and meet in a common center, and the other end of each of them diverge and ſpread out from this center to ſome diſtance, though generally not very far.

It frequently happens, that a vaſt body of ore is found in the center of this accumulated vein; and when the ore is dug out, a moſt tremendous gulph is opened below ground, which is ſometimes of an irregularly arched or conical figure; but whatever figure the excavations aſſume, there is nothing in the practice of mining ſo awful and dangerous as the waſte or excavations of an accumulated vein.

Now, it is fair and reaſonable to ſuppoſe, that there may be vaſt accumulated veins of feuel in ſome volcanic mountains, perhaps of much greater extent and dimenſions than we can eaſily conceive; however, the excavations of theſe, though vaſt and extenſive, are nevertheleſs of an arched or conic form; and therefore, the ſuperficies is ſupported, and does not fall in. Theſe ſubterraneous excavations may be compared to ſome immenſe Gothic temples, which, though of vaſt dimenſions, the roof lofty, and compoſed of maſſy and ponderous materials, yet the fabric is firm and durable, becauſe it is ſupported by walls, buttreſſes,

treſſes, and pillars, proportioned to the immenſe weight of the ſuperſtructure: But we ſhould remember, that this is only comparing great things with ſmall to aſſiſt our ideas.

When the reſult of theſe enquiries is fairly examined, we ſhall be authoriſed to infer, that whether we ſuppoſe the combuſtible matter, which is the feuel of the volcanoes, to be contained in mineral veins, or in regular ſtrata, it is exhauſtible. The progreſſive advances of ſome volcanoes, in a line from the firſt funnel or crater, is a proof that the feuel is exhauſtible; and, moreover, ſome few volcanoes have been extinguiſhed. We may alſo aſſert of the volcanic feuel, that it is not only limited in quantity and exhauſtible, but that it is lodged in very widely different quantities in different places, like all other mineral matter. This obſervation is ſufficiently proved by the different magnitude and extent of different volcanoes, which is the very beſt proof the ſubject is capable of, there being no poſſibility of ſurveying theſe treaſures of fire.

It is fair and reaſonable to ſuppoſe, that the volcanic feuel treaſured up in Mount Ætna, and in the line of progreſs of that tremendous ancient volcano, has been many thouſand times as much as ſome diminutive volcanoes, which can only be ſaid to exiſt in a comparatively harmleſs ſtate, without being of ſufficient magnitude or force to do much harm. All mineral ſubſtances whatever, whether uſeful or curious, are found, in very widely different quantities, in all the different places we dig for them, or ſee them baſſet out, where the ſuperficies of the ſtrata are laid bare by ſtreams of water, or otherwiſe; and we are confident to aſſert, that there is the ſame variety or difference of quantity of volcanic feuel as of other mineral matter. Theſe diſquiſitions are not the fruit of ingenuity and conjecture: Obſervation and experience aſſure us, that it is difficult to ſet bounds to great and little when applied to the concavities or capacities of mineral veins. We have ſeen ſome very ſmall and diminutive, and we have ſeen others exceeding large and capacious; and there is no room to doubt, that there are others deep down in the bowels of volcanic mountains, which are prodigiouſly larger and more capacious than any that we ſee or penetrate in our diminutive mole-like operations and reſearches.

I ſuppoſe that new volcanoes will occaſion but weak and harmleſs earthquakes, becauſe there is not as yet extenſive excavations made for the reception of copious vapours; however, in proceſs of time, the continual conſumption of the volcanic feuel will ſoon make room enough to contain a ſufficiency to puſh out ſtreams of lava, or, by quick exploſions, to throw quantities of rubbiſh high up into the air.

The inflammable vapour in coal mines frequently does this laſt in miniature. The encreaſe and dilatation of a great cloud of ſteam lodged behind a quantity of liquid fire or melted matter, will forcibly propel and thruſt it out through the mouth of the crater. There is no room to ſuſpect the propelling force of ſteam and rarified air in any direction whatever, it being the action of fire; and the more it is confined, the more powerfully it will act. If once it collects in force behind any quantity of lava, or other matter, it will violently puſh it out at the old, or burſt a new paſſage. We are enabled to conceive a tolerable idea of the prodigious extent and capacity of the excavations of old volcanoes from the quantities of matter ejected out of them.

Where we ſee countries overſpread with lava for many miles in extent, and to a vaſt depth, and know, that beſides the lava, immenſe quantities of pumice, aſhes, and other rubbiſh, have been thrown out in different ages, we muſt conclude, that the volcanic excavations are large and extenſive, in proportion to the quantities of matter ejected out of them; and moreover, when the original ſite of volcanoes are near the ſea, perhaps we cannot gueſs at one half of the matter ejected, becauſe immenſe quantities of it have been thrown into the ſea, where it lies buried in the waters out of our ſight. However, we ſee enough of it to aſſure us, that the excavations below are of monſtrous extent and capacity; and I have no doubt that this is the reaſon or cauſe of the earthquakes of old volcanoes being ſo extenſive, and ſo dreadfully miſchievous in their effects, even at a great diſtance from the original ſite and crater; ſuch, for inſtance, as the late earthquakes in Sicily and Calabria. I dwell the longer upon theſe abſtruſe diſquiſitions, with intention to endeavour, by every means, and by every explanation in my power, to impreſs upon the minds of all thoſe who read theſe papers, an apprehenſion of the great danger of inhabiting volcanic ground, and eſpecially every where in the line of an old volcano. The dreadful cataſtrophes which have ſo frequently happened in Sicily, Calabria, Peru, Jamaica, and many other parts of the world, are but too ſure proofs of this danger; but there is, in many inſtances, a ſort of infatuation in mankind. We are apt to overlook and forget our danger when the cauſe of it lies out of ſight. I have, in theſe diſquiſitions, endeavoured to explain, and to expoſe the cauſes of danger; and as far as my knowledge and powers of deſcription will reach, I have endeavoured to make the danger viſible to the mental eye, to the end that thoſe concerned may flee from it, at leaſt, with their cities, ſea-ports, and manufactories, and leave the volcanic ground for the purpoſes of huſbandry only. I have before hinted at the parallelifm of the veins which contain the volcanic feuel; and although there ſhould be ſeveral of them running parallel to one another, ſo as to conſtitute a line of conſiderable breadth, they will nevertheleſs ſtill continue their parallelifm; that is, they will continue to run or trend parallel to one another, and to the bearing of the ſtrata.

It is certainly the greateſt temerity imaginable, to think of dwelling immediately above ſuch pits of deſtruction; into which thouſands have fallen almoſt in our ſight, and thouſands more will fall into them, if theſe matters are not ſeriouſly and timeouſly taken into conſideration, and put in practice by the philoſophic and legiſlative powers of thoſe countries, and it muſt be done by their united force; for ſuch great and ſalutary improvements are never ſet about and accompliſhed without their joint exertions; and although theſe diſquiſitions are ruſtic, they are not trivial. Their intention is to point out the danger, and the means of eſcaping it, and the better that all branches of natural hiſtory are underſtood, the better we are enabled in all caſes to provide for our convenience and ſafety; and it appears to me rational to ſuppoſe, that improvements

ments and advances in the knowledge of the natural hiſtory of volcanoes, ſhould prove the means of mitigating the evil conſequences of them. Accurate knowledge of the cauſe of any evil, is generally conſidered as the firſt means of preventing its effects; and I think this obſervation particularly applicable to the ſubject of our preſent enquiries; and I humbly hope, that the above will not be thought improper hints for laying the foundation of improvements in the natural hiſtory of volcanoes.

I might now proceed in my enquiries, and attempt to inveſtigate the original cauſe of the firſt beginning of volcanoes; but as the ſubject is both difficult and myſterious, and appears to me merely curious, I will not ſpend much time in diſquiſitions that can be of little or no utility as far as I yet know. It is very well known, that there are various quantities of the vitriolic, and other pyrites in all countries; and theſe pyrites are ſometimes found pure and unmixed, and ſometimes blended with other foſſil ſubſtances. The pyrites are frequently found between the ſides, and in the concavities of mineral veins, in very widely different quantities, and in different degrees of purity or of mixture. The pyrites are alſo frequently found in very different quantities, imbedded in maſſes and plates, &c. of various ſizes, in the ſtrata of coal, and in many of the ſtony and argillaceous ſtrata which accompany coal; and moreover, it is ſometimes found combined with, but concealed in inviſible particles, thoughout the whole ſtratum and maſs of the coal, in ſuch quantities as frequently to raiſe a fermentation, when ſuch coal is worked, and parcels of it laid down in any place that is acceſſible to the common air; and this fermentation firſt raiſes ſome heat, which is by degrees encreaſed, until at laſt the heaps of coal are ignited by it; and ſeveral large parcels of coal here in Scotland have been in a conflagration, and actually conſumed, by the fermentation of the pyrites; as, for inſtance, at Ayr, and at Brora in Sutherland. We know, and have ſeen parcels of the pyrites fermenting alone to the degree of ignition, when they have been thrown aſide above ground; however, I will not aſſert, that ſuch parcels were perfectly free from particles of coal adhering to ſome of the maſſes of pyrites.

Whether the fermentation of pyrites alone, or of ſulphur and iron, or any others of the ſemimetals, are adapted by nature for kindling and feeding the fire of volcanoes, or whether it is not neceſſary that there ſhould be ſome bituminous or oily matter to increaſe and feed the flame, I will not pretend to determine. Perhaps other inflammable ſubſtances are alſo neceſſary at firſt to light and feed the flame; and ſuch, to my certain knowledge, are frequently mixed in leſſer or greater quantities with various ſtrata, and are found lodged in mineral veins. Petroleum is widely diffuſed through the Mineral Kingdom; and it is ſo plentifully combined or mixed with the ſubſtance of many ſpecies of ſtones and other foſſils, as to cauſe them to flame ſtrongly in the fire, though not to conſume; and in many parts of the world, the petroleum is in ſuch abundance as to iſſue out to the ſurface of the ground in great quantities.

There is a ſpecies of remarkably pure and fine coal, of a particularly rich and fat quality, depoſited in the concavities of mineral veins, which I myſelf have ſeen in ſeveral parts of the Highlands of Scotland. The greateſt quantity of this coal is to be ſeen at Caſtleleod in Roſs-ſhire, where ſome of the veins have been opened and tried, and the coal found to be of an uncommonly rich and fine quality; a particular account of which I gave before in my natural hiſtory of coal.

The nature and ſituation of this ſpecies of coal is extraordinary, and quite out of the courſe of common experience, being found in the concavities of rake-veins, or perpendicular mineral fiſſures; whereas, other foſſil coal is always found in regular ſtrata. I only ſaw this coal in very ſmall quantity of a few inches thick, in every place where I diſcovered it, excepting at Caſtleleod, where, in ſome of the bellies, pipes, or ſwellings of the veins, it was up to three or four feet.

Now, this brief ſketch may ſuggeſt to us, at leaſt a probability, that beſides the immenſe ſtores of pyrites which are ſuppoſed to be lodged at firſt in the bowels of volcanic mountains, there may alſo be leſſer or greater quantities of petroleum, or of a ſpecies of foſſil coal, as at Caſtleleod in the Highlands of Scotland, or of ſome other combuſtible matter, either mixed and blended with the pyrites in the ſame veins, or depoſited ſo near to one another, as that the combuſtibles would at firſt be readily ignited by the fermentation of the pyrites; and they may afterwards continue to the end reciprocally to inflame and conſume one another. As I have ſeen different quantities of foſſil coal in the cavities of mineral veins in ſeveral parts of the Highlands of Scotland, it cannot be called a ſtretch of vague conjecture to ſuppoſe, that the ſame, or ſome other inflammable ſubſtance may be depoſited in the volcanic mountains, though the fact cannot be aſcertained; becauſe the ſuperficial parts of the volcanic feuel is there all conſumed away long ago. We may form ſeveral conjectures how a volcano is at firſt ignited; as, by elementary fire, or great and uncommon flaſhes of lightning kindling ſome eaſily inflammable ſubſtance, or of ſuch flaſhes of elementary fire kindling dry and parched vegetables, and the conflagrations of theſe vegetables communicating fire to the ſuperficies of a vein of ſome combuſtible foſſil ſubſtance. With reſpect to this laſt conjecture, it may be obſerved, that the principal crater of many of the ancient volcanoes, is ſituated higher up on the mountain than any vegetation is ever found; and as to the firſt, the inflammable foſſils, eſpecially ſuch of them as partake of the nature of coal, are not ſo readily inflammable as to be ignited by a ſudden tranſient flaſh of elementary fire; and, therefore, the moſt probable conjecture in my opinion is this: viz. That volcanoes are at firſt ignited by pyrites at the ſurface.

Moderate humidity, and the contact or action of the external air, has a great tendency to excite and encreaſe the fermentation of pyrites; and it is obſervable, that the ſummits of moſt volcanic mountains are covered with ſnow the greateſt part of the year, and we cannot imagine a ſituation where the fermentation of theſe ſubſtances would be more powerfully excited than beneath the ſnow; and in lower ſituations, which are not often covered with ſnow, we may ſuppoſe, that the minerals have been ſufficiently moiſtened by long and heavy rains, or by a copious ſpray from the ſea. But after all that I have ſaid, or perhaps that can be ſaid upon this myſterious ſubject, I may not exactly hit the mark. I do not pretend poſitively to aſſert any thing. All that I can do is, to point out ſeveral obſervations and facts, and leave the reader to form a judgment of them for himſelf. My own opinion of the origin or ignition of volcanoes is this: I obſerved above, that accumulated mineral veins are found in ſome mining countries, where a number of nearly perpendicular fiſſures meet and join in one common center, from which they ſpread out like radii to different diſtances from the central conjunction. Now I ſuppoſe, that there was one of theſe accumulated veins in each volcanic mountain; that the central part of the vein came up to the day at or near the ſummit of the mountain; that this vein contained pyrites, perhaps mixed with other inflammable combuſtible foſſils; that the rains, and eſpecially the ſnows, excited theſe inflammable mineral ſubſtances to ſuch a degree of fermentation, as to be at laſt ignited; and that, when they were once ſet a-going, the fire would firſt prey upon the ſhaft or central column of the vein, which of courſe would form in time a vaſt perpendicular cavity, reſembling the inſide of a prodigious tower, without floors or ſtories, or the inſide of a glaſs-houſe. Some of theſe accumulated veins of vaſt magnitude have been ſeen and explored in the practice of mining, and in cavernous mountains.

Now, as theſe concentrating veins are ſeen of different degrees of magnitude, it is agreeable to analogy and experience to ſuppoſe, that deep down in the bowels of volcanic mountains, theſe veins have opened and expanded to degrees of wideneſs and capacity far exceeding any thing we have ſeen, and that they have been repleniſhed with volcanic feuel. Upon this hypotheſis, the firſt great excavation of a volcano ſhould be much in the form of an irregular conical ſhaft, the crater being the mouth of the ſhaft, the extent of which is ſometimes ſeen; but we can ſay nothing about the depth, dimenſions, and capacity of theſe volcanic ſhafts below out of our ſight. But whatever the extent and capacity of them may be deep down in the bowels of the mountains, this account of them preſents to us the idea of a ſtrong arched figure, like a glaſs-houſe, every part of which is well ſupported upon its own baſis; and I am fully convinced, that this ſubterraneous form is the real cauſe or reaſon why thoſe mountains do not fall down into the immenſe gulphs and excavations below. In the progreſs of the volcanic conflagrations, ſome of the diverging rays or branches of the accumulated vein will communicate with veins of another deſcription, which trend in a line parallel to the bearing of the ſtrata; and as the volcanic feuel is the prevailing mineral ſubſtance or ſubſtances of that diſtrict, the parallel veins will likewiſe be repleniſhed with volcanic feuel; and therefore, in proceſs of time, the volcanic fire will prey upon theſe veins, and advance in a horizontal direction; and when theſe excavations are become extenſive and capacious, they alſo become dangerous and deſtructive, as at Meſſina, Calabria, Jamaica, &c.

Some noted volcanoes, ſuch as thoſe of Iceland, not only emit great quantities of ſteam, but they alſo throw out great quantities of hot water high up into the air ſeveral times every day. We preſume, that the natural cauſe of this phenomenon is a ſubterranean river, and a thin partition wall of rock interpoſed between the river and the volcano. This partition wall muſt be a ſpecies of fire-ſtone, perhaps baſalts, ſome of the varieties of which is the beſt fire-ſtone that we know of; that is, it ſtands the heat of a furnace, or any other hot fire, better than any other of our hard ſtone; and we are told, that baſaltine rocks abound in Iceland, and eſpecially in the neighbourhood of the volcanoes, and that the apertures, through which the hot water is ejected there, are in rocks of baſalts. This partition wall being heated to different degrees, may produce the different phenomena and ejections of the water and ſteam; and, moreover, in ſome of them, there may be a paſſage or gap below, in what may be called the banks of the river, over which the water may run ſometimes, and fall down into the volcano, which may be the cauſe of its raging more furiouſly, and of ejecting the water, &c. with more force and violence than ordinary.

I will now proceed with ſome diſquiſitions concerning volcanoes, which are not of ſo ſerious a nature, nor ſo intereſting as part of the foregoing diſquiſitions, being ſuch as have more regard to truth than utility. One of the principal motives which induced me to write any thing concerning the mineral kingdom was, to attempt to obviate errors, and to ſet the world right in many particulars, and alſo to lay the foundation, and give a clue to aſſiſt young naturaliſts in the ſtudy of this important branch of natural hiſtory.

I ſaw, that falſe facts and abſurd concluſions from them were daily impoſed upon the world; and as I knew this, I could not juſtify myſelf without detecting ſuch errors, and communicating my knowledge of a great many facts which have been miſrepreſented by ſeveral eminent writers, who have neither taken the pains, nor had the opportunities of ſeeing ſo much of the mineral kingdom as I have; and ſome of them are too much attached to a favourite ſyſtem to acknowledge truth, if they ſaw her adorned with all her excellencies and lucid beauties. How far I have ſucceeded in this part of my plan and intention, muſt be determined by the judgment of the candid naturaliſt.

When groſs miſtakes and abſurd concluſions are publiſhed by men of eminence in the republic of letters, as indubitable facts, they have very pernicious effects, by encreaſing difficulties in the knowledge of nature, and eſtabliſhing ſcepticiſm; and, by the ſanction of great names, ſuch erroneous opinions become the vogue; and, therefore, every novice will ſay ſomething on that ſide of the queſtion, although he knows very little about the matter.

I have thoroughly inveſtigated and made myſelf maſter of every thing I repreſent as fact. I wiſh that all the modern writers about the concerns of the mineral kingdom had done ſo likewiſe.

There are two foſſil bodies, which are claimed by many, as only belonging to volcanoes, namely *baſalts* and *tufa*, which really and truly belong to the mineral kingdom in general. Theſe I will endeavour to reſcue from this unjuſt detention, and to reſtore them to their proper ſtations in the ſyſtem of nature. Becauſe baſalts is often found about volcanic mountains, they produce this circumſtance as a proof of its being chryſtallized by the fire of the volcano; but I affirm, that real baſalt is a real ſtone, and part of a real ſtratum, the exterior parts of which are frequently formed into columnar and glebous figures, which happened at firſt by drying.

However, I will not pretend to ſay, that ſome of the curious gentlemen, who carefully examine volcanoes, may not ſee ſome fragments of baſaltine rocks which have fallen from the ſummit or ſides to the bottom of a crater, which may be thrown out again by eruptions of the volcano, with real marks of fire on them; notwithſtanding, this accident does not alter the nature of things. Real baſalts is ſtill a real ſtone, which belongs to a very numerous and a very extenſive claſs of ſtrata, the natural hiſtory of which I have ſo fully explained formerly, that little or nothing more need be ſaid about it here; only we may ſafely and fairly obſerve in general, that the modern gentlemen of the Pyrrhonian ſyſtem are as famous for drawing inferences from a ſhallow knowledge of their ſubject, when treating of the mineral kingdom, as any ſet of philoſophers that ever appeared in the world.

I have made it evident to ocular demonſtration, that the baſalts are as much, and as really rocks and ſtrata, as any rocks and ſtrata in the ſuperficies of our globe; and as ſuch, they conſtitute a conſiderable material part in the conſtitution of this great fabric, having as regular ſtrata above and below them, as any we behold in the ſuperficies of the globe, and the baſaltine ſtrata ſpread as wide, and ſtretch as far in the longitudinal line of bearing, as any of their concomitant ſtrata; and therefore, we cannot allow their being called lava, any more than the other ſtrata found above and below the baſalts; and if ſome of them, namely, the ſtrata of coal, were to come in contact with burning or running hot lava, they would ſoon make ſuch a conflagration in that part of the globe, as would produce more lava, not like baſalts, but like dirty ſlags, ſuch as we have ſeen where ſeams of coal have been accidentally ſet on fire. The baſalts, as I hinted before, is a real ſtone, compoſed of different grains and particles of other ſtones, ſuch as principally of quartz and ſhirl, with ſome admixture of iron and mica, and leſs or more earth, according to the perfection or debaſed quality of the ſtone.

Now, the quartz and ſhirl approach in their natural ſtate to a chryſtaline ſtone, that is, they have the fineneſs and purity of chryſtal; and although quartz is found of ſeveral colours, and ſhirl, as far as I know, always black, yet, nevertheleſs, they both produce the fineſt tranſparent uncoloured chryſtal when vitrified, unleſs there is ſome mineral admixture to colour it. In ſhort, baſalts is found, by chemical experiments, and by every other examination, to be as really and truly a ſtone, as any other rock in the world. But I need not proceed. The ſtrata of baſaltine rocks keeping their ſtations in the ſuperficies of our globe in every country where they are found; their ſpreading as wide, and ſtretching and dipping down as far as the concomitant ſtrata which are placed above and below them; and ſtrata of coal being found and wrought both mediately and immediately above the ſtrata of baſalts, is as ſatisfactory and convincing as a thouſand demonſtrations, to prove that baſalts is not lava, nor chryſtalized from a fuſion by fire, but ſtrata of rock; and which ſtrata of rock bear a conſiderable bulk, and are regularly placed among the ſeveral other ſtrata which form the ſtupendous ſtructure of the ſolid ſuperficies of our globe; and if any man doubts the truth of this aſſertion, he may ſee it with his eyes in the neighbourhood of Bo-neſs, and in many places among the hills upon both ſides of the road betwixt Bo-neſs and Bathgate, almoſt all over Fife, and in ſeveral other parts of Scotland; and moreover, there are as regular and as beautiful columnar baſalts in the Bathgate hills, particularly at Hillhouſe lime-quarry, a mile ſouth of Linlithgow, as can be found in any country, with ſtrata of coal and of limeſtone above and below the ſtratum of columnar baſalts; and this is not a ſingular phenomenon in this country, ſtrata of baſalts being very common in the coal-fields of the Lothians, Fife, Ayr-ſhire, &c. and they are frequently found in extenſive ſtrata in their proper ſtations, among their concomitants, in the north of Scotland, where there is no coal; which facts are concluſive, and prove beyond a doubt, that baſalts is as real, and almoſt as extenſive ſtrata of rock, as any other in the conſtructure of the ſuperficies of our globe.

I will now make ſome enquiries concerning *tufa*, which our modern naturaliſts ſay is only produced by the volcanic fires, which I deny. But in order to point out the true origin, and to illuſtrate the natural hiſtory of *tufa* or *tofus*, it may be proper for me to take a curſory view of ſome of the ſtallactital productions, which are ſo near of kin to the tufa's, that they are originally of the ſame family; and it is pretty generally known, that the ſtallactites are ſtony concretions.

That water percollates the pores, and paſſes through the fiſſures of the ſtrata, is a truth well known to all foſſiliſts; and it is as well known, that water carries various particles along in its ſubterraneous motion. While this ſubterraneous water is excluded from the external air, it continues to carry about the terrene particles that are combined or mixed with it; but when it iſſues out into the external air, or into any cavern or ſubterraneous receptacle into which air has acceſs, then the quantity of water is immediately leſſened by evaporation, and of conſequence, it muſt drop ſome of the minute foſſil particles and leave them behind. So long as the ſubterraneous water is excluded from the action of the external air, it may be ſo perfectly combined with various heterogeneous particles, as to appear to be nothing but a pure tranſparent liquid, although it contains conſiderable quantity of earthy matter. "When air, ſays Lord Kames, comes in contact with water, it proves a ſolvent;" and melts it down to ſteam, or particles ſmall enough to riſe buoyant in the atmoſphere, which doctrine is certainly true; and I think this as clear and evident as any thing of the kind can be, and it helps to explain the proceſs of nature in forming petrifactions, concretions, and ſome ſpecies of ſediment, eſpecially thoſe of the ochreous kinds.

If water was always to remain in equal quantity and force as when it took up the terrene particles in its ſubterraneous paſſage, it would leave none of them behind: They would all be carried forward to the ſea. But the contrary is the fact: The water is in part diſſolved into particles inconceivably ſmall, or evaporated, and the ſtony particles are left behind in caverns, &c.

which particles form, by the gradual accretion of matter, the ſtallactites, and other ſtony concretions. I have ſeen old deſerted mines and coal-works contain great quantities of theſe productions; and in ſome places, they form in much leſs time than I imagined before I ſaw it with my own eyes.

A great many ſubterraneous caverns are repleniſhed with great quantities of theſe ſtony concretions; among which, the caves of Nigg, at the ſea ſide, a little way to the eaſt of the entrance into the bay of Cromarty, are not the leaſt remarkable. All the ſtallactites in thoſe caves are calcareous, and of a very fine texture. Either ſome corroding waters paſſing through beds of lime diſſolve part of it, or elſe common water percollating the pores and cranies of the ſtrata, finds the lime by the way in ſmall particles, which it carries along; but when the water iſſues out of the roof and ſides of ſuch caverns, the water is evaporated ſlowly, by coming in contact with the air in the cave, and the ſtony particles are left behind, and lay the foundation of theſe curious ſtallactital productions, which are ſtill enlarging and improving by the continual accretion of matter; that is, by the minute particles which are carried and left by the water. While the ſtony matter is in a fluid ſtate, before the water has quite deſerted it, it is ſpread out ſlowly by the remaining water, over all parts of the maſs actually forming, and then the reſidue of the water evaporates ſlowly, and leaves the ſtony matter there upon the maſs, by which proceſs all thoſe ſeveral bodies of ſtone are formed ; that is, all the petrifactions and ſtony concretions are formed, and gradually come to perfection, by this ſecret proceſs of nature. The greateſt and moſt material difference between theſe concretions and thoſe of another quality is this : All the ſtallactital bodies in the caves of Nigg, and many others which I have ſeen, are compoſed of calcareous particles, which will efferveſce with acids, and produce lime when calcined. The other concretions are formed by the ſame proceſs of nature, of vitrifiable particles, which will not efferveſce with acids, nor produce lime by calcination, but are eaſily vitrified or melted to glaſs or ſlag.

The caves of Nigg proved to me a moſt amuſing and inſtructing ſcene. I found there ſome of the ſtallactites formed ſo very hard and perfect, that a blow with a ſtrong ſtick made no impreſſion upon it. It was as white as alabaſter, and of ſo fine a texture, as to be capable of receiving a good poliſh. Upon trying other parcels I found, that the pick had a little impreſſion upon ſome, that it eaſily pierced others, and I could thruſt my finger into ſome of the maſſes, although they had much the ſame external appearance as the hardeſt. In ſhort, I could there trace petrifaction or concretion in all its ſtages. I ſaw ſome no thicker than cream, and again ſome of the conſiſtence of milk, and high up towards the roof, I perceived ſome as thin as whey, the water there being only a little coloured, and could diſtinctly diſcern it thickening, as it came gliding ſlowly down the ſides of the cave; which was an ocular proof that the water evaporates by degrees, and leaves the ſtony matter thus to inſpiſſate, and at laſt to become as hard as marble.

It evidently appears, to the conviction of our ſenſes, that a ſmall and a diminiſhing quantity of water ſuits this proceſs beſt. Were all the water which iſſues out of the roofs of caves in many places to continue in full force, and none of it to evaporate, it would carry all the terrene particles away with it in a ſtream, out at the mouth of the cave. There are a number of antique groteſque figures thus formed in the caves of Nigg, and no balluſtrades or organ-pipes ever appeared ſo magnificent as the ſtallactital pipes and columns I ſaw there, and in many other places.

There are great quantities of the concreted ſubſtance called *tufa* in many parts of Scotland, in high and low lands, north and ſouth. Tufa is always found upon the ſurface of the earth, unleſs it ſhould happen by accident that ſome adventitious cover is thrown above it. It is commonly ſituated below ſome ſmall, ſlow, or weak ſprings, and it generally appears in a whitiſh or aſhen-grey coloured, porey, and moderately light marle-like ſubſtance, frequently ſpread out pretty wide and high, reſembling at a diſtance ſome whitiſh miſhapen rocks. I have ſeen much of this concreted ſubſtance wet, ſpungy, and ſoft as mud, while the water which lodged the particles was partly mixed with it before the water had time to be completely evaporated; and I have ſeen it dried and indurated to various degrees of hardneſs, and profitably burnt for lime. The proceſs of nature, in the formation of this tophic ſubſtance, is to be explained upon the ſame principles as the ſtallactites. A ſmall rill or quantity of water iſſuing out to the ſurface of the ground, and carrying ſtony particles with it, part of the water is immediately evaporated ſo ſoon as it comes in contact with the external air. By this evaporation, the rill of water is continually diminiſhing as it advances forward from the aperture out of which it iſſues, and creeps among the graſs along the ſurface of the earth; and conſequently the ſtream is weakened in its career, retarded in its motion, and ſome of the ſtony particles are at firſt lodged in the graſs or otherwiſe; and when theſe firſt lodged particles are accumulated to any thing of a conſiderable maſs of tufa, there becomes at laſt little or no run of water at all, it being detained in the chaotic maſs of the forming matter. A conſiderable part of the moſt recent ſediment frequently remains for ſome time wet, ſoft, and ſpungy, like mud, in which all the water that ſtrains out of the ground or rock is abſorbed and detained, until it has time to be evaporated by degrees, and the concreted maſs to acquire firmneſs and conſiſtence. I have frequently ſeen tufa forming immediately beneath the ſide of lime-rocks, where the quantity of water was ſo ſmall, as only to ſlide gently down the rock, without forming a rill; and where the water iſſued out in ſuch quantity, as to form a rill or ſtreamlet at the foot of the rock, I have ſeen the maſs of tufa accumulated high and wide, and ſtretching to a great diſtance below the rock; and it is worthy to be remarked, that where the rill of water iſſuing out of a lime-rock, or elſewhere, is ſo ſtrong and copious, ſummer and winter, as to be able to carry all the ſtony particles away with it in a full collected current, no maſs of tufa ſhall be accumulated in ſuch places; but the bottom and ſides of the rill, or channel of the little current, is generally covered with a whitiſh cruſt, by ſome of the ſtony particles ſticking to every thing as they paſs along.

A novice in the natural hiſtory of foſſils, may at firſt ſight doubt the truth of the aſſertion, that ſtallactites and tufa have the ſame origin and efficient cauſe, from ſeeing a very diſtinguiſhable difference in the internal and external appearance of the maſſes of both kinds; and I confeſs, that the difference of the inner and outer appearance of the maſſes of both is abundantly obvious; and, therefore, for the ſatisfaction of ſuch, I will explain the natural reaſon of this apparent difference.

I obſerved before, in general, that this difference in appearance is occaſioned by the different ſituations where they are formed; but I muſt be more particular and explicit.

Below ground, the ſtallactites in caverns are generally found hanging pendulous attached to the roof, or adhering to the ſides of the cave, or formed upon the floor, by drops of water falling directly down from the roof. In that ſituation, the water generally iſſues out in very ſmall quantity; and in its deſcent from above, it glides gently and ſmoothly down the ſurfaces of the maſſes which are forming. The exhalation or evaporation of the water goes on but ſlowly in that ſituation, there being perhaps little air admitted, and that little comparatively damp and ineffectual for want of free circulation; of conſequence, the particles of matter, which are very ſmall, can be laid on the encreaſing maſs but leiſurely, and, the water ſtill gliding down, lays theſe ſmall particles cloſe together upon the maſs, and keeps the ſurface of it continually as ſmooth and gloſſy as if it was poliſhed. In the formation of tufa upon the ſurface of the earth, the evaporation and waſte of the water, on the contrary, is more copious and haſty, being expoſed to the external air and ſun; and, of conſequence, the terrene particles are precipitated more haſtily, and in much greater abundance; and theſe particles, which are large, are more rudely propelled and huddled together into an irregular confuſed maſs, which ſwells and gorges in different parts, by the remains of the water being detained in it, as in ſnow in a rainy day, which of conſequence muſt produce a looſe porey miſhapen maſs of petrifaction. When one quarter of the general maſs of tufa is grown high and extenſive, by the ſtagnating and gorging of the water in paſſing through the newly precipitated ſtony matter, as formerly mentioned, the water then turns aſide from ſome part of it, and immediately begins to make an addition to the bulk of the accumulated maſs upon the ſide it now runs to, in the ſame manner as above-mentioned; and then that part of the maſs which the water has newly left, gets time to dry and harden, by degrees, as the water is ſtrained and evaporated out of it. I have ſeen ſome parts of large maſſes of tufa, which were high above the preſent courſe of the water, dried and indurated to ſuch a degree, as to make them difficult to be quarried for burning to lime, although ſuch parts, when firſt formed, or rather while forming, were nothing better than a puddle of calcareous mud, much reſembling half ſnow half water in a rainy thaw; and I have frequently wet my feet in both of them.

I think, that I have been abundantly explicit in unfolding the natural hiſtory of the ſtallactites, and of the tufa, and therefore, I will now proceed and point out ſome few of the many places where I have ſeen the tufa; but I cannot now diſtinctly remember, perhaps, not one in a hundred of the particular ſpots where I have really ſeen it. There is ſome tufa beneath a ſpring in the Hill of Carlops, about twelve miles ſouth of Edinburgh, upon the north-eaſt ſide of the hill, and pretty high up.

I have a faint remembrance of having ſeen tufa in the hill of the farm of Carlops, and I went lately there in order to aſcertain the fact, and I ſaw it about a quarter of mile above the Bridge of Carlops, upon the ſouth ſide of the rivulet. It is remarkable of the tufa at Carlops, that ſome of it contains a conſiderable quantity of moſs and graſs, which has been enveloped by the ſtony particles, and it is preſerved in the maſſes of the tufa ſo perfectly, as to look like petrified moſs, which makes this tuſa the more curious, and worth the examination of the young naturaliſt. There is a great quantity of moſs upon that mountain, thro' which the water of the ſpring creeps, and leaves the terrene particles behind in dry weather, which forms tufa among the moſs; but the ſide of the hill is ſo ſteep, and the current of the ſpring ſo rapid, in wet weather, that a great deal of tufa is then ſwept down the hill to the rivulet, and eſpecially when the ſnow is melting. Theſe circumſtances, with the ſtrength of the ſpring, prevent the tufa from greatly accumulating, which it certainly would if the ſituation was more favourable. There was much more of it twenty-five years ago than there is at preſent.

There is a quantity of tufa near Troup, in Aberdeenſhire, ſituated near a lime-kiln between the houſe of Troup and the village of Gardenſtoun.

I have ſeen tufa in the iſland of Iſla in ſeveral places, particularly near the ſouth or ſouth-eaſt of the limeſtone field in that iſland, where I diſtinctly remember to have ſeen one very large parcel of it accumulated like large miſhapen rocks. Now, it cannot be pretended, that there are any volcanic ſymptoms near either of theſe places. It is a particular loſs to theſe local remarks, that when I ſaw tufa in the greateſt number of places, I had no view of ever having occaſion to point out to the public ſuch a common natural production; otherwiſe I could have enriched this page with perhaps more than threeſcore; and I could have pointed them out as diſtinctly as the above-mentioned three; but as the very identical ſpots do not now occur to my memory, I will give nothing from uncertain gueſs or conjecture.

Having now pointed out and explained the true origin and nature of tufa, the application of what I have advanced about it to the ſubject in queſtion is plain and ſimple. It is abundantly evident, even to the ſligheſt enquirer into theſe matters, that the tufa has no more connection with, nor relation to volcanoes, than to any other place where calcareous or other particles of ſtony matter exiſt, and are ſo ſituated, that they can be taken up and carried along by water, either into ſubterraneous caverns, or out to the ſurface of the ground.

Tufa may be found upon a volcanic mountain, in the near neighbourhood of a volcano, or of volcanic matter, as well as in any other place, where ſtony particles may be found and carried by water. Rain water and melted ſnow, percolating the ſtrata of a volcanic mountain, and iſſuing out of any part of the ſides or bottom of the mountain, may bring particles of ſtony matter out with it, and ſo tufa may be formed at the bottom or upon the ſides of ſuch a mountain. And again, the rain water and melted ſnow paſſing through the pores and crevices of the ſtrata of a volcanic mountain, and falling down into the excavations of the volcano, may form tufa within the concavities of the mountain, if the water is combined with ſtony matter ; and it is to be ſuppoſed, that the water will find plenty of it in paſſing through ſuch extenſive rocks as thoſe of a large volcanic mountain.

If we look attentively into this matter, we can eaſily imagine the inſide or excavations of a volcanic mountain to be a plenteous repoſitory of tufa, where it is formed in greater abundance, and far more expeditiouſly, than it poſſibly can be formed any where upon the ſurface of the earth. Some of thoſe mountains are known to have been volcanoes for two or three thouſand years, and the quantity of lava and other rubbiſh thrown out of them by different eruptions is immenſe. Now, the depth and extent of the excavations of thoſe mountains, muſt be in proportion to the quantities of matter ejected out of them. Upon ſome of theſe mountains, a prodigious depth of lava, aſhes, and other rubbiſh, is ſpread out for ſeveral miles from the crater, and other apertures, out of which the ſeveral deſcriptions of volcanic matter are ejected : What prodigious excavations of conſequence muſt there be within the bowels of ſuch mountains ! I am perſuaded, that the firey caverns of ſome volcanoes are much deeper, and extend much further from the original craters than we generally imagine. The extent of the excavated caverns, or their diſtance from the apertures, muſt be in proportion to the accumulated or diffuſed ſtate of the veins of pyrites, or other volcanic feuel. The narrower and more confined theſe veins are, the further from the crater the ſubterraneous excavations muſt extend, to produce ſuch immenſe quantities of lava, and other rubbiſh, which has been thrown out of them.

It is well known to mineraliſts, that the pyrites, and other inflammable foſſils, are oftener found in veins and ſtrata, of no great thickneſs, than in vaſt accumulated heaps; but theſe ſtreight veins and ſtrata frequently extend far in the line of bearing; and this great length of the veins is the phyſical cauſe of ſome volcanoes advancing ſo far in the horizontal line, from the bottom of the original funnel, as ſometimes to paſs under the waters of the ſea from the main land to an iſland, or *vice verſa*, and from one iſland to another; and it is the cauſe of eruptions ſometimes in the waters of the ſea, when a vein or ſtratum of volcanic feuel happens to come up too near the ſurface of the ſolids, under the water of the ſea. And, moreover, this is the real cauſe of many volcanoes laſting ſo long as they do. If the whole ſtore of volcanic feuel was accumulated contiguous

ous to the firſt volcanic aperture, the conflagration would be amazingly great and violent while it laſted ; but it would ſoon conſume all the feuel, though ever ſo great in quantity ; but, according to the real conſtitution of things, or, in other words, according to the natural hiſtory of the mineral kingdom, a vein or veins, a ſtratum or ſtrata of combuſtible matter, not many feet in thickneſs, may feed the interior fires for ſeveral thouſand years ; but then it is neceſſary, that the fire makes very extenſive progreſs downwards, and in the line of bearing from the firſt crater of the volcano.

Now, it is eaſy to conceive, that this prodigious extent of excavation and length, of courſe, muſt cut and interſect a great number of ſubterraneous ſprings and currents of water, which will let down a vaſt quantity of water into the ſeveral caverns and receptacles of the volcano.

In ſome places, not only large and copious ſprings, but even conſiderable rivulets, are drained by the progreſſive advancing of volcanoes, and every drop of the water ſo drained from the ſurface, muſt go down into the excavations of the volcano. It is well known, that water, in its natural ſtate, contains a conſiderable quantity of earthy, ſtony, or ſaline matter, &c. and the dried ſprings, rain water, and melted ſnow, percollating the pores, and paſſing through the crevices of the ſtrata of a volcanic diſtrict, muſt carry down very much ſtony matter with it into the various parts of the excavations, by which means great quantities of tufa will be formed or produced, in a comparatively ſhort time, by the immenſe heat of the volcano evaporating the water to ſteam almoſt as faſt as it falls down. It is certain, that every drop of that water is evaporated, and goes off in ſteam; and, of conſequence, the ſtony particles carried down by the water will be left behind, of which various quantities of tufa are formed in different places. When the heat of the volcano is great, the water will be evaporated, and fly off in ſteam with great rapidity; and, of conſequence, as the ſtony particles cannot be evaporated, the ſubterraneous tufa will form with equal rapidity, and no doubt ſucceſſive eruptions will ſweep it out through the crater and other apertures, and lay it ſomewhere or other upon the face of the country in the neighbourhood of the volcano. It may be objected to me, that, in my hiſtory of the ſtallactites, I repreſented that thoſe petrifactions only are formed in ſubterraneous caverns, but that tufa is not formed there, but above ground, which is true of ordinary caverns; but the volcanic excavations are not ordinary caverns. In the cool receptacles of the mountains or cavernous ſhores of the ocean, the progreſs in the formation of ſtallactites is exceeding ſlow, becauſe

evaporation

evaporation is exceeding ſlow, on account of the ſmall quantity of air that is admitted there, and on account of the dampneſs and tardy motion of that ſmall quantity; whereas, on the contrary, in the volcanic caverns the quantity muſt be greater, a thouſand times hotter, and, of conſequence, in a thouſand times quicker circulation, owing to the outrageous heat; and the great heat and quick circulation or motion of the internal air, will occaſion a prodigious quick evaporation, and of courſe the terrene particles muſt be huddled together very haſtily, and left looſe and porous in the form of tufa, reſembling in texture a maſs of wet lump-ſugar or half melted ſnow; and as it is haſtily formed in the cavities of the volcano, ſo may it be as haſtily thrown out to the ſurface by different eruptions, and in the form of "liquid mud," as it is called; at the ſame time I am confident, that it was not the firſt matter that iſſued from Veſuvius, nor from any other volcano, although it might either iſſue out, or be ejected many times afterwards, when the excavations of the volcano became capacious and extenſive enough to let down ſufficient quantities of water for producing it. I might point out a great many ways how tufa may be formed in the neighbourhood of volcanoes, and yet it might happen to be produced in many other forms and ſituations, which I would not be able to conceive nor explain, without inveſtigating circumſtances upon the ſpot ; but I do not think it neceſſary to ſay any more about the matter, as I imagine, that what I have advanced in explanation of the natural hiſtory of tufa, will be abundantly ſatisfactory to convince the unprejudiced naturaliſt, that tufa has no more to do with volcanoes than with any other places, where terrene particles and water may be combined together, and afterwards either fall into the volcanic excavation, or iſſue out to the ſurface of the ground, in ſituations favourable for the production of that petrified concrete.

From what has been ſaid it evidently appears, that the tufa is not a ſufficiently ſolid foundation upon which to build any part of an hypotheſis reſpecting the eternity or duration of the world, it being an adventitious ſubſtance, much of which is a recent production, and which is continually forming, and it will continue to be formed ſo long as the world endures in its preſent condition ; and, therefore, it is not neceſſary after this for naturaliſts to carry the idea of volcanoes, or volcanic matter, in their heads, when they ſee tufa ; as it evidently appears, that it has no manner of relation to volcanoes, any more than to other places, which are favourably ſituated for its production. It is to be ſeen formed, and now forming, in ten thouſand places upon the face of the earth, far enough from volcanoes, or from any volcanic matter. Tufa is to be ſeen formed and forming in at leaſt a thouſand different places in Great Britain; and there is no real ſymptom of a volcano ever having been within this iſland.

Perhaps ſome of theſe ſyſtematic gentlemen, who generally call in every thing to countenance a favourite hypotheſis, may imagine, and they have aſſerted, that they ſee tufa beneath ſome of the real ſtrata of the native rock; but they ſhould be a little more cautious than they often are of aſſerting too boldly what they are not ſure of. Tufa may be found at the foot of a rock, and attached to it, and if there was any original cavern or variety, it may be filled up with tufa; but it is never found between real and regular ſtrata; and theſe gentlemen ſhould remember, that there is ſuch a degree of reſemblance between ſome beds of clay, and of marl, and other argillaceous ſtrata, and alſo between ſome of the mineral ſoils, ochres, &c. and the tufa, as may be readily miſtaken by ſuch gentlemen as have not had opportunities of much accurate obſervation, and long experience, in matters relating to the mineral kingdom.

That foſſil ſubſtance found upon or near the ſurface of the ground, called *puzzollano*, may happen to be ſubterranean tufa, compoſed of calcareous and ferruginous particles, burnt to a great degree in the furnace of a volcano, before it was thrown out by violent eruptions; and the great degree of heat it then ſuffered, with the mixture of iron it contains, may be the cauſe of the abſorbent quality which it is known to poſſeſs; but as I am not very well acquainted with the puzzolano, I will ſay no more about it.

In this æra of learning and ſcience, the inquiſitive ſpirit of reſearch, with philoſophy in her company, traverſe the bounds of the univerſe in purſuit of knowledge, and new diſcoveries are daily made; and all the tribute of praiſe and acknowledgment which the warmeſt gratitude can expreſs, is due to many modern names, for the numerous local obſervations, and the many facts which have been communicated to the world relating to phyſics and antiquity, ſince the commencement of the eighteenth century. But it muſt grieve a benevolent man, who has more regard to truth than to ſyſtem, when he ſees ſo many men of learning and worth ſtrenuouſly endeavouring to found and ſupport a ſyſtem of falſehood, abſurdity, and nonſenſe, in oppoſition to the phenomena of heaven and earth, and in flat contradiction to the opinion and belief of ſober reaſon and ſound philoſophy in all nations, from Socrates to Sir Robert Boyle:—I might ſay, from the beginning of the world until now. Several modern philoſophers may juſtly be termed innovators in phyſics and chronology.

They pretend to prove to a demonſtration, that the world itſelf is of a much older date than the earlieſt accounts which are handed down to us from all antiquity, written or traditional; and ſome of them will allow it no beginning at all, for no other good reaſon that I know of, but becauſe they did not ſee the beginning of it. I will relate one pretended fact, which has been lately diſcovered and made uſe of, to overthrow the chronology of the Pentateuch, and indeed, all ancient chronology whatever; which fact, is ſaid to be well atteſted. It is related in Brydon's tour through Sicily and Malta, which I will give in his own words:

"When we came near the ſea in the neighbourhood of Catania, I was deſirouos to ſee what form the lava had aſſumed in meeting with the water. I went to examine it, and found it drove back the waves for upwards of a mile, and had formed a large black high promontory, where before it was deep water. This lava, I imagined, from its barrenneſs, for it is as yet covered with a very ſcanty ſoil, had run from the mountain but a few years ago; but was ſurpriſed to be informed by Signor Recupero, the hiſtoriographer of Ætna, that this very lava is mentioned by Diodorus Siculus to have burſt from Ætna, in the time of the ſecond Punic war, when Syracuſe was beſieged by the Romans.—A detachment was ſent from Tauraminium to the relief of the beſieged.

They were ſtopt in their march by this ſtream of lava, which had reached to the ſea before their arrival at the foot of the mountain, and entirely cut off their paſſage, and obliged them to return by the back of Ætna, upwards of an hundred miles about. His authority for this, he tells me, was taken from inſcriptions from Roman monuments found in this lava, and that it was well aſcertained by many of the old Sicilian authors.

"Now, as this was about two thouſand years ago, one would have imagined, if lava have a regular progreſs in becoming fertile fields, that this muſt long ago have become at leaſt arable. This, however, is not the caſe; and it is as yet only covered with a very ſcanty vegetation, being incapable either of producing corn or vines. There are, indeed, pretty large trees growing in the crevices, which are full of a very rich earth; but, in all probability, it will be ſome hundred years yet before there is enough of this to render it of any uſe to the proprietors."

"Near to a vault which is now thirty feet below ground, and has probably been a burial-place, there is a draw-well, where there are ſeveral ſtrata of lavas, with earth to a conſiderable thickneſs over the ſurface of each ſtratum. Recupero has made uſe of this as an argument to prove the vaſt antiquity of the eruptions of this mountain. For if it requires two thouſand years or upwards to form but a ſcanty ſoil on the ſurface of a lava, there muſt have been more than that ſpace of time betwixt each of the eruptions that has formed theſe ſtrata. But what ſhall we ſay to a pit they ſunk near to Jaci of a great depth. They pierced through ſeven diſtinct lavas, one over the other, the ſurfaces of which were parallel, and moſt of them covered with a thick bed of fine rich earth. Now, ſays he, the eruption that formed the loweſt of theſe lavas, if we may be allowed to reaſon from analogy, muſt have flowed from the mountain at leaſt fourteen thouſand years ago."

I will not pretend to diſpute the date when the promontory was formed by the lava, nor do I queſtion the authenticity and exactneſs of the experiment of the pit. I give the ſame credit to both which I do to other hiſtorical facts; but I have ſeveral things to obſerve concerning the concluſions drawn from thoſe facts.

In the firſt place, I would aſk the gentleman who was preſent at digging the pit, if he is certain that the lava did decay at all, ſo as to be converted into ſoil? I think the caſe very doubtful, eſpecially if the lava was perfect or thoroughly vitrified; and their finding ſuch a number of ſtrata of ſoil and lava alternately, makes it ſtill more doubtful.

Is it well aſcertained, that the ſurface of a ſtratum of lava decays and moulders down before the center? If they ſay it is, I then aſk how they came by this certainty? Is it by obſervation and experience? If it is, then it muſt happen within a much ſhorter period of time than the one laid down to calculate the age of the world by, as no men in theſe ages live up to two hundred years.

For my part, I have ſome reaſon, from my own obſervation, to doubt the outſide of lava decaying before the inſide. I ſaw the ruins of ſeveral ancient vitrified forts in the Highlands of Scotland, ſituate upon the level ſummits of ſmall hills of the breccia. There was a ſection made, a few years ago, quite through one of thoſe ſingular forts, beginning without all the ruins, and digging to the rock, and keeping down to the ſolid rock, until they came to the vitrified wall that ſurrounds the level area upon the top of the hill, which was the area of the fort. They continued the cut to the rock through that wall, through the middle of the area of the fort, and through the oppoſite wall.

There was alſo a ſection made half way thro' an out-work, which defended the principal acceſs to the fort. The perſon who attended the cutting of thoſe ſections, was as inquiſitive as the Sicilian gentlemen poſſibly could be; and he noted down every diſcovery and obſervation he made upon the ſpot. I need not obſerve that the ruins of thoſe forts have a near reſemblance to lava, and in fact are lava; the whole wall being vitrified and run together by the force of fire into coarſe glaſs or lava.

Now, it is a fact worthy remarking in this place, that in making the ſections above-mentioned, the parts of the lava or vitrification which were moſt expoſed to the external air, were by far the hardeſt, in ſo much, that in going through the ruins of the ſouth wall, where large fragments were expoſed to the air without any manner of cover, the workmen could not break ſome of them; but were obliged to roll them out along the trench with levers, until they tumbled over the brow of the hill; and they were obliged to dig a paſſage under one fragment, which was too large to be removed, and leave it like a bridge over the cut; on the contrary, the north wall, though much deeper and broader than the ſouth, was nevertheleſs much eaſier dug through, it being covered with rubbiſh, which had fallen upon it from a row of houſes built within the fort againſt this wall. The north wall had been as well vitrified as the ſouth to the full; yet was it eaſier cut through, being covered from the external air. The vitrified ruins of the houſes which had been reared againſt the north wall facing the ſouth, were ſtill more decayed than the wall, ſo as to be eaſily broken to pieces, and they were buried much deeper under rubbiſh and earth. The ruin of the north wall was about fourteen feet high or deep, of clean vitrified matter, and very broad, the top of the wall being fallen down; but the ruin of the out-work was about twenty-four feet high, though all was fallen in and cruſhed together. This great heap of ruins produced ſome vitrified fragments on the out-ſides; but when they entered a little way in with their ſection, they ſoon found more, which increaſed as they advanced, and before they were one third of the way through, there was nothing found but vitrified ruins from top to bottom, except about a foot of ſoil and rubbiſh which lay above the whole. As they advanced in with the cut, they met with many large fragments, which had been fully as well vitrified as any part of the walls; they were, nevertheleſs, all very eaſily broken, and thoſe which were high up fell to pieces with their own weight, when they tumbled down. Now, in all theſe experiments, it was found, that the more the lava of thoſe extraordinary ruins was covered from the external air, the more it was found in decay. The one end of the hill, which was the ſite of this fort, ended in a narrow ridge, upon which there was the ruin of a long narrow out-work, ſtretching in a right line from the fort. This never had been above eight or ten feet broad. There is the cleareſt veſtigia of their having a draw-bridge about the middle of it. There is a gap in the ruin, and a ditch in the ground where the bridge has been, to prevent acceſs paſt the bridge to the ſurrounding wall of the fort. It is natural to reflect, that as this wall or outwork was ſo narrow, much of it would be expoſed to the air, and all the changes of the weather, which is pretty ſevere in that country; it being ſituate about two miles weſt of Dingwall in Roſsſhire, and about nine hundred feet of altitude above the valley immediately at the foot of the hill.

Now, it is remarkable, that this narrow outwork, though moſt of all expoſed to the air, is ſtill more entire than any other part of the ruins, which corroborates the foregoing obſervations, and increaſes the doubt of the lava of volcanoes decaying firſt at the ſurface. And moreover, I ſaw one of theſe curious ruins within two miles of Inverneſs, where there had been an outer and an inner fort all vitrified.

The inner ſurrounding wall, which has been by much the higheſt, is now nothing but a heap of rubbiſh mixed with vitrid fragments. The outer wall, on the contrary, never was high, and of conſequence, not ſo apt to tumble down by its own weight in length of time; of courſe, it would continue to be expoſed to the air and weather, and there is now ſome part of this wall ſtanding entire upon the bare rock where it was firſt founded. I look upon this entire piece of the remains of theſe extraordinary ruins as one of the greateſt curioſities in Europe.

There was a pamphlet wrote ſome time ago, containing ſundry obſervations about the diſcovery of thoſe ancient remains; and from traditions picked up, it is ſuppoſed in the pamphlet, that the one near Dingwall was the ancient Selma ſo often celebrated in Oſſian's Poems. Be that as it will, theſe ruins are certainly very ancient. It is near two thouſand years ſince the Romans landed firſt in Britain, after which period, there was no occaſion for ſuch extraordinary ſhifts in cementing ſtrong walls, as the uſe of lime in building was about that time introduced into the iſland.

Theſe obſervations about the remains and fragments of the vitrified forts, certainly make it exceeding doubtful whether the lava of volcanoes moulder firſt at the ſurface; and their finding ſtrata of lava between the ſtrata of ſoil, makes it more doubtful. I cannot help thinking what I have ſaid ſufficient to ſtagger the faith of the unprejudiced in the concluſions drawn from the obſervations made in Sicily; and the obſervations concerning the lava of the vitrified forts, are as real facts as the Sicilian; and, as they are at home, the truth of them can be more eaſily examined.

But we need not proceed. It is well known to all thoſe who are in the leaſt acquainted with the hiſtory of volcanoes, that prodigious ſhowers of aſhes are frequently thrown out of the craters, and ſometimes to a great diſtance, which produces a ſtratum of good ſoil at once, and as effectually in leſs than twoſcore, as in two thouſand years; and this fact is as well known to the gentlemen of the new ſyſtem as to any others in the world, although in this inſtance they chuſe to conceal part of their knowledge, which is particularly faulty in ſuch plain, ſimple, and obvious facts, which invalidates the truth of all they advance, and tumbles the whole fabric of their ſyſtem at once to the ground. That aſhes, pumice, and other rubbiſh, are very frequently thrown out of volcanoes, and ſpread wide over the face of the country, is too commonly known to admit of any diſpute, and certainly theſe ſhowers of aſhes will fall upon beds of lava, as well as upon any other part of the country; and as the contiguous parts of the country next the volcano are generally covered with lava, the ſhowers of rubbiſh and aſhes have a greater chance to fall upon lava than upon any other ground. I made it evident before, that tufa is formed very expeditiouſly in the excavations of volcanoes; and I have all the reaſon in the world to believe, that there is a proportion of tufa in theſe ſhowers of aſhes.

There is no room to doubt of there being tufa mixt with the aſhes, and this mixture will greatly enrich the compoſition, and haſten its melioration into good ſoil. Now, the ſituation of the above-mentioned promontory is not ſo favourable for acquiring a thick coat of ſoil in ſo ſhort a ſpace of time. Its diſtance and ſite may not be convenient for receiving ſhowers of aſhes and rubbiſh; and moreover, a promontory is ſuch a windy ſituation, that every thing is blown off rather than on to it. I have myſelf ſeen the ſoil evidently decreaſing upon ſome promontories in Britain, and moſtly all blown off the farther end of ſeveral in Aberdeenſhire, Caithneſs, &c. But I need not multiply words. It is obvious to every unprejudiced enquirer who will examine circumſtances, that there might be a greater depth of ſoil made upon the one place in leſs than twoſcore of years, than upon the other in much more than two thouſand. When I look ſeriouſly into this ſubject, I cannot help admiring the credulity of theſe gentlemen in building ſo high upon ſuch an inſufficient foundation. Some of theſe celebrated facts are founded upon ſingle local circumſtances, are but ſlightly atteſted, and it is impoſſible to prove the truth of the concluſions. They are founded upon hypotheſis alone; and, moreover, the fact I hinted at before of ſhowers, of aſhes, &c. mixed with tufa, overthrows the hypotheſis, and makes all their reaſonings upon it chimerical and abſurd. It is highly probable, that the boaſted experiments or pits were made on purpoſe to countenance an eſtabliſhed perſuaſion. I care not what name or figure any one of theſe gentlemen bears in the world. He is a man, and ſo am I, and as ſuch I am as deeply intereſted, as an individual, in all the concerns of this world, and that which is to come, as he is; and, therefore, I have a right to examine the truth of what he propoſes to me upon ſo intereſting a ſubject, and to detect the fallacy of his propoſitions, if it is inmy power, and I think it my duty ſo to do.

In this freedom of enquiry, I will venture to ſuggeſt, that if any man, or number of men, were to take the hiſtory of the experiments upon the lava in their hands, and to go to the ſpot, and dig a hundred pits through all the ſtrata of it, I doubt if their diſcoveries ſhall correſpond with the hiſtory, or come any thing near it; no, not in one ſingle place out of the hundred; and the reaſon is plain and obvious. Volcanoes, with their eruptions and lava, are not regular operations of nature, but dreadful accidents, attended with the moſt horrible confuſion and diſorder. It is an indubitable fact, atteſted by a multitude of unprejudiced eye-witneſſes, that eruptions of volcanoes are ſometimes exploded with ſuch amazing violence, as to force a prodigious quantity of matter high up into the air ; and, at other times, theſe aſtoniſhing exploſions throw the matter many miles off into the ſea, or on to the land, which frequently makes ſhocking havock and devaſtation.

When lava iſſues out, it is attended in its appearance and conſequences with ſtill greater horror and deſtruction. Fields, woods, ſtone-walls, farm-houſes, and populous towns, are all driven before it, or whelmed under it with irreſiſtible force and deſtruction. In ſuch horrible confuſion, it is impoſſible to aſcertain the numberleſs accidents that may happen. All the vegetable and combuſtible ſubſtances that come in contact with the fire, will be conſumed at once ; but the upper ſoil of the deſtroyed fields will be driven before the prodigious weight of the fiery deluge, and thrown this way and that, at all poſſible uncertainty where or how. Some parcels of it may be incloſed or overwhelmed betwixt layers of burning matter, and other parcels of it may be ſurrounded by meeting currents of fluid fire, and form little iſlands or neſts of ſoil, which will be overflowed and buried by the next deluge of fire that iſſues out, perhaps that very day, or the next, or the next year. And will any ſober man pretend to draw important inferences from ſuch horrible devaſtations and utter confuſion as this, and call them well atteſted facts? Their credulity appears to me as aſtoniſhing as the confuſion upon which they build their inferences, if they really are deceived themſelves by ſuch falſe lights; but if they are not, why then the gentlemen are pleaſed to divert themſelves with our ignorance and credulity. To think them ſerious, is but a very poor compliment to their penetration and philoſophy. But I take up too much time in expoſing ſuch vague and fallacious concluſions. It is fully evident from what has been ſaid before, as well as from ſome parts of their own hiſtories of volcanoes, that the phenomena which they diſcover, and build upon, might all happen within fourteen hundred years, as well as in fourteen thouſand years twice told.

Singular Obſervations and Improvements.

THE fifteenth century is remarkable for having produced ſome of the greateſt events that ever were recorded in the Hiſtory of the World. The foundation of a great revolution was laid in Europe, which, in its conſequences, relieved millions from a double ſlavery, and procured for them not only civil liberty, but alſo the liberty of the mind, which had long been kept in darkneſs, bound faſt in the cruel ſhackles of an imperious uſurping tyrannical prieſt, whoſe galling yoke depreſſed the ſpirits and marred the proſperity of almoſt all Europe, and who aimed at enſlaving and oppreſſing all nations. The way to the Eaſt Indies by the Cape of Good Hope was diſcovered, which rouſed the attention and enlarged the ideas of a people who had newly knocked off their fetters: A new ſpring was given to commerce, and all the States of Europe were enriched thereby. But the greateſt and moſt wonderful of all the events which that century produced, was the diſcovery of a new world by Columbus, nearly equal to the old in magnitude, and in many places exceeding the old world in fertility, and the excellence of its productions.

The queſtion how America was firſt peopled has been long bandied about among the learned and inquiſitive, and the world has been favoured with many ſtrained conjectures to explain that difficulty. Among the great number of conjectures which have been ſtarted upon this puzzling queſtion, ſome have come pretty near the truth, though none as yet have explained the point in a ſatisfactory manner. I have not the leaſt doubt that the Old and New Continents are joined together; that America was firſt peopled by the north; and that the firſt inhabitants of it, man and beaſt, walked there by land.

But it may be objected to me, that ſuppoſing the two Continents are joined together, and that there is firm land all the way. Allowing this to be true, there ſtill remain inſurmountable difficulties in the way. The frozen regions of the north are impaſſable. Mountains of ice and frozen ſnow are there heaped upon mountains of ice and frozen ſnow, until they are piled up into the higher regions of the atmoſphere, and more is ſtill accumulating, which renders that way abſolutely inacceſſible to man or beaſt.

I will readily grant, that the north has long been impaſſable, and, I am confident, that it will continue to be ſo to the end; but at the ſame time I will aſſert, that there was a period of time when this paſſage was clear and open. The world itſelf, and every thing in it, had a beginning; of conſequence the mountains of frozen ſnow had a beginning; and, before that beginning, the paſſage by the north was clear.

There were then neither mountains of ice nor ſnow; and before the mountains of ice and ſnow began to accumulate, America was, or might be, peopled by land from the Old Continent.

It is not ſo eaſy to prove when the mountains of ice and ſnow began, as that they really had a beginning. The laſt propoſition is ſelf-evident;

but it is difficult to point out the beginning of that accumulation. It is more than probable, that in the early ages after the flood, the froſt and ſnow of winter would diſſolve and melt away in ſummer, even near the poles, as it does now in more temperate climates. In the courſe of time, ſome little would remain all ſummer upon the higheſt mountains, which might continue to increaſe for ages, before it entirely ceaſed thawing in the valleys and lower grounds every ſummer. It is well known by experience, in the vicinity of high mountains, that the remains of frozen ſnow have a great and ſenſible effect upon the climate of the countries near the ſnow; and that while the ſnow remains upon the mountains, the air continues cold and chilly, even in ſummer, and vegetation advances but ſlowly. From this experienced fact, it is obvious to reaſon, that the gradual increaſe of the frozen ſnow in the northern regions, would likewiſe affect thoſe climates by degrees, until at length it would become extremely cold through the whole length of ſummer; and this gradual increaſe of ſnow, and the conſequent increaſe of the coldneſs of the climate, would by degrees prepare matters for a final change. The worſe the climate grew, the harder and ſeverer the winters; and the colder the winter, the more ſnow would remain over ſummer; and at laſt, an uncommonly ſevere winter would pour down ſuch a prodigious quantity of ſnow, that the enſuing ſummer could not melt and diſſolve it away off the lower grounds; and then the foundation of thoſe prodigious mountains of ice and frozen ſnow was laid, which have been accumulating ever ſince; and it is impoſſible for us to judge of the height and extent of this accumulation. Before the beginning of theſe accumulated maſſes of ſnow, the paſſage by the north, between the two continents, was clear and open, but now it is ſhut up for ever; and it is highly probable, that this event happened in an early age after the flood; which, in my opinion, helps to account for the Americans forgetting their origin, and being forgotten by the people of the Old Continent.

It is obſervable, that the Americans in general have but very little notion of ſociety and government; and that they are very ignorant of the manners and cuſtoms of the Old Continent: However, it is not at all wonderful to find them ignorant of our manners and cuſtoms, when we reflect that their emigration was ſo very remote. We muſt ſuppoſe that they ſuffered many and ſevere hardſhips at firſt; and perhaps they might have been reduced very low before they diſcovered and ſettled in the milder climates, and more fertile parts of America; and nothing in the world has a greater tendency to reduce mankind to a ſtate of ſavage ruſticity, than great and inſufferable hardſhips.

With reſpect to the comparatively more cultivated ſtate of ſociety, and the fragments of knowledge found among the people of Mexico and Peru, it is probable, that they were obliged to ſome of the ancient Britons for their ſuperior degrees of knowledge and improvement. It is recorded in the hiſtory of the ancient Britons of Wales, and recognized by the great Lord Lyttleton in his hiſtorical works, that about ſix hundred years ago, Madoc, the brother of the reigning Prince, being well ſkilled in navigation, and having ſome difference with his brother and Sovereign, equipt a ſhip, and ſailed weſtward in queſt of diſcoveries: That he diſcovered land, and after informing himſelf of the nature of the country, he came back to Britain, fitted out ſix ſhips, and ſailed away the ſecond time, with a numerous colony of men and women, but was never more heard of.

When this hiſtorical fact is impartially examined, it ſeems to throw a gleam of light upon the hiſtory of that country, and to account for the advanced ſtate of ſociety and civilization in Mexico and Peru, while all other parts of that immenſe continent were found in a ſtate of ſavage ruſticity. I am of opinion, that the continent of America was peopled at firſt from the north-eaſt of Aſia. The copper colour and thin beards of the people of Eaſt Aſia, and of America, ſeem to favour this conjecture. We are told that the native Americans have no beards. Now, a very thin beard is the next thing to none at all; and perhaps, the food and climate of the Americans, and their manner of living in general, might, in the courſe of time, have the effect of increaſing a natural imperfection, until by degrees it arrived at the extremity of no beard at all. But however that might be, there is great reaſon to believe, that the continent of America is joined to the north-eaſt of Aſia. A very great number of attempts have been made, for near two centuries back, by many of the beſt navigators in the world, to find out a north-weſt, or a north-eaſt paſſage to India, but all in vain hitherto. The attempts to diſcover a north-eaſt paſſage have been innumerable, by the ſhips of almoſt all the nations of Europe; but they were all repulſed in puſhing north-eaſtward, either by land, or by ice and ſhallow ſoundings, which is much the ſame thing, as ſhallow water is ſeldom found far from land. This great point is now fully decided beyond a doubt, by the juſtly celebrated Captain Cook, and by his ſucceſſor Captain Clerk, who both of them ſought a paſſage from the weſt and north ſide of the continent of

America to the Atlantic ocean; but they were equally unſucceſsful with the attempts from the ſouth and eaſt ſides of that continent. Captain Cook traverſed the weſt and north-weſt coaſt of America, from the back of Canada, in the north latitude 44. to the northern extremity of that continent; and along the north-eaſt coaſt of the continent of America, to where it joins the continent of Aſia, ſouth-weſt of Kamſchatka; and he every where found evident and convincing marks of that part of America being a great and extenſive continent. About the north latitude 59. he found an immenſe river, up which he ſailed above two hundred and ten miles; and ſaw, that it came from a vaſt continent which, in thoſe latitudes, was wholly covered with ſnow down to the ſea-beach, in the months of June and July. It is very well known, that ſuch magnificent rivers as this are never found upon narrow ſlips of land, but always derive their ſources off the extenſive ſurfaces of great continents.

This great and worthy navigator, and his ſucceſſor, Captain Clerk, carefully examined the north eaſtern coaſt of America, where it joins the Continent of Aſia, to the weſt or ſouth-weſt of Kamſchatka; and they ſaw with certainty, that the two Continents were joined together in one continued firm land.

When Captain Cook came to the coaſt of Aſia, he ſailed a good way in ſight of the north-eaſt coaſt of that part of the Old Continent, and then he ſailed weſtward again to the coaſt of America; and he ſailed along the north-eaſt coaſt of the New Continent, until he was fully ſatisfied that it joined the Old; and when he could proceed no further with the ſhips up a narrow inlet and ſhoal water between the two Continents, he "diſpatched Lieutenant King, with two boats well manned and armed, to make ſuch a ſearch as might tend to aſcertain the point with certainty."

Lieutenant King was out two days, and he tells us, that "the crews of the boats rowed without intermiſſion towards the land till one o'clock the next morning, when Mr King, upon his landing, aſcended the heights, from which he could ſee the two coaſts join, and that the inlet terminated in a ſmall creek or river, before which there were banks of ſands or mud, and in every part ſhoal water. The land for ſome diſtance towards the north was low and ſwampy; then it roſe in hills; and the perfect junction of theſe on each ſide of the inlet was traced without the leaſt difficulty. From the elevated ſituation in which Mr King took his ſurvey of the ſound, he could diſcern many ſpacious valleys, with rivers flowing through them, well wooded, and bounded by hills of a moderate height. One of the rivers towards the north-weſt ſeemed to be very conſiderable; and he was inclined to ſuppoſe from its direction, that it diſcharged itſelf into the ſea at the head of the bay. To this inlet Captain Cook gave the name of Norton's Sound, in honour of Sir Fletcher Norton, now Lord Grantley, a near relation of Mr King." This inlet is ſituated in about 70 degrees of north latitude, and about 190 of eaſt longitude.

See page 225. of the Abridgement of Captain Cook's laſt Voyage.

To the above extract I will beg leave to add another paragraph from page 270. of the ſame book. When enumerating Captain Cook's diſcoveries, the writer ſays, "His third and laſt voyage, however, is diſtinguiſhed above the reſt, by the extent and importance of its diſcoveries. Not to mention the ſeveral ſmaller iſlands in the Pacific Ocean, he diſcovered the group, called the Sandwich Iſlands, which, on account of their ſituation and productions, may perhaps become an object of more conſequence than any other diſcovery in the South Seas. He explored what had before remained unknown of the weſtern coaſts of America, an extent of three thouſand ſeven hundred miles; aſcertained the proximity of the two Continents of Aſia and America; ſailed through the ſtraits between them; and ſurveyed the coaſts on each ſide, ſo far as to be ſatisfied of the impracticability of a paſſage in that hemiſphere from the Atlantic into the Pacific Ocean, by an eaſtern or a weſtern courſe. He has, in ſhort, completed the hydrography of the habitable globe, if we except the Japaneſe Archipelago, and the ſea of Ameer, which are ſtill imperfectly known by Europeans."

No man was ever better qualified for reſearches of this nature than Captain Cook. No man had ever more experience nor equal ſucceſs in theſe reſearches; nor could any man be more faithful, inquiſitive, and attentive to all circumſtances than he was; and, therefore, his account of theſe things is always to be relied on with abſolute confidence.

But to return to the conſideration of the improvements of Mexico and Peru, it appears to me very probable, that Prince Madoc diſcovered Mexico in his firſt voyage: That he began to inſtruct the Mexicans in the rudiments of agriculture, building, weaving, of the uſe and comfort of apparel, and of the advantages of ſociety, and the regulations of government. He could not at firſt communicate his ideas to them in words, for want of an interpreter; and, therefore, he was under the neceſſity of making uſe of ſigns, and it is pretty certain, that he would be obliged to delineate ſome of his thoughts upon paper, if he had any, or upon linen, or ſome other flat ſurface, before he could be underſtood by them; and this may be the origin of the art, which the Mexicans were maſters of, when the Spaniards firſt landed there, of painting upon cotton cloth the intelligence ſent in their diſpatches to the Emperor of Montezuma, inſtead of writing them, which they could not, having no knowledge of letters.

Madoc might have no women with him in his firſt voyage. When he had conſidered the nature and the wants of the country, he would ſee the neceſſity of having European cattle, corn, iron, artiſts, and many other articles, to lay the foundation of a laſting and a comfortable colony; and, moreover, he would have a laudable ambition and a benevolent deſire to carry over ſome of his relations and beſt friends to partake with him the happineſs and glory which he expected to enjoy in the fine country, which he had the honour of diſcovering, and which he meant to improve and civilize. When Madoc came back to Britain, he might leave two or three of his men behind him, to aſſiſt the Mexicans in carrying on the improvements which he had begun, until he returned with a colony, and European materials, and conveniencies.

Madoc came back to Britain, fitted out ſix ſhips, and ſailed away for America the ſecond time, with a numerous colony of men and women, but was never more heard of.

Misfortunes and diſappointments have blaſted the towering proſpects and apparently well-founded hopes of multitudes, not only of the ſanguine and imprudent, but alſo of the moſt wiſe, the moſt cautious, and beſt of men, in all ages and countries. Though Madoc was ſucceſsful in his firſt voyage, he certainly was unfortunate in the ſecond. There is great reaſon to ſuppoſe, that he was overtaken by a ſtorm from the north in his ſecond voyage, which would drive him to the coaſt of Brazil, or ſome other part of South America, where his little fleet was wrecked, and all his ſanguine views, and well concerted plans, were overwhelmed in the waves, and none but himſelf and his wife, and perhaps two or three men, were ſaved. It has been obſerved by thoſe who firſt explored South America after the Spaniſh invaſion, that here and there a perſon more fair and white than ordinary was ſeen among the wandering copper-coloured hordes. If any of the Britons eſcaped from the devouring deep, and reached land in their boats, or otherwiſe, after their ſhips were caſt away, the ſavages would kill the men, and ſave the women on account of their beauty and novelty; and this may be the origin of the few fair people ſeen in South America.

Madoc would ſave himſelf, his wife, and the few who were with him in the boat, either by keeping off from the land at firſt, or by flying timeouſly from danger. The wreck of his fleet might happen in ſight of, or not far from the great river of Amazons. When he diſcovered the immenſe opening of the mouth of that river, the largeſt in the world, which is fifty leagues wide where it enters the ocean, he would naturally imagine it to be an arm of the ſea, which communicated with the gulph of Mexico; and, therefore, he would boldly enter it, and ſail and row up the ſtream until he reached the Lake Llauricoch, out of which a navigable branch of that river iſſues; and this lake is but a ſhort diſtance from Cuſco and Lima, the ancient and modern capitals of the empire of Peru. When the Spaniards firſt conquered this great and wealthy empire, they were informed by the natives, that about four hundred years before the arrival of the Spaniards, a man and woman of majeſtic form, and cloathed in decent garments, appeared to them all at once upon the borders of a lake, who declared that they were the children of the Sun, ſent by their benevolent parent to reclaim and inſtruct mankind, and to lead them in the way to happineſs. The period of time fixed by the Peruvians for the firſt appearance of the founders of their empire, correſponds exactly with the time of the emigration of Prince Madoc and his company. Madoc was undoubtedly obliged at firſt to uſe ſigns in Peru, as well as in Mexico, to make himſelf underſtood. He might point to the ſun as the chief guide he made uſe of, by his obſervations, to lead him to their country, from which the Peruvians might infer, that theſe ſtrangers, who afterwards proved ſo worthy of their high regard and veneration, were the children of that glorious luminary, of whoſe benevolent and powerful influences their country enjoyed ſo large a ſhare. Or; perhaps, Madoc might judge this to be a proper political fiction to engage and fix the attention of the ſavages he was to collect and rule, as it were under the immediate eye and daily cognizance of a powerful viſible god. The benevolence of the Peruvian emperors in general, the flouriſhing and happy ſtate of ſociety through the whole extent of that great empire, when Pizarro the Spaniard invaded it, are clear proofs of the wiſe inſtitutions eſtabliſhed by their benevolent law-giver; but from the accounts of theſe people given us by the Spaniards, the moſt ſuperſtitious corrupt ſect of chriſtians in all Europe, we can form no proper idea, at this diſtance of time, what theological precepts Manco taught his people.

The Peruvians called this extraordinary pair Manco Capac and Mama Ocello. Manco and

Madoc have a likeneſs of ſound, and Mam Ichel is a *high mother* in the ancient Britiſh language. But I am perfectly ſenſible of the uncertainty and fallacy of conjectural etymology, and the ſimilarity of the ſound of words, and therefore I will drop that topic. We have more certain and poſitive proofs, that ſome wiſe and benevolent European came among theſe people, and laid the foundation of the improvements of ſociety, and the happy inſtitutions of their government.

It is ſaid, that the wandering ſavages of Peru differed but little from wild beaſts when Manco firſt appeared among them, and that he began to collect them together, and to form ſocieties in a hilly country, which was the likeſt to his own country which he had left, if we ſuppoſe him to be Prince Madoc. In ſailing up the river of Amazons, he would be made ſenſible of the putrid damps and unhealthy climate on the banks of that great river. The powerful rays of the ſun in the arid valleys of Peru would at firſt be intolerable to a man juſt arrived from the cold and rainy mountains of the weſt coaſt of Britain, who muſt of neceſſity be continually out of doors to teach and lead his people to till the ground, and raiſe the neceſſaries of life; and this firſt choice of his reſidence is no unfavourable ſymptom of the wiſdom and genius he afterwards diſcovered in the foundation and improvements of his empire. Manco firſt began to teach the Peruvians to till the ground, to raiſe plenty and variety of food, and to build houſes to lodge the different families apart, and ſcreen them from the open air and the changes of weather, with other uſeful and neceſſary arts.

Mama Ocello likewiſe began her truly glorious and benevolent reign in imitation of her huſband, and taught the women to ſpin and weave, and to make garments to clothe their nakedneſs. When Manco had inſtructed his people in the neceſſary arts of ſocial induſtry, and to raiſe and preſerve plenty of proviſions, he then proceeded to form proper laws and regulations of ſociety, ſuitable to the climate and other circumſtances, and to teach his people good morals, the rules of juſtice and benevolence, the advantages of induſtry as the ſource of plenty, and the other ſocial and neceſſary virtues; and great things are ſpoken of the civilization, the happy government, and mutual felicity of the Peruvians, throughout their widely extended empire, before the Spaniards came to deſtroy them; and the Spaniards have proved themſelves a cruel nation of murderers, and exterminators of the human race, both in Europe and America. We are told, that the Peruvians divided the year, as we do, into 365 days; that they had ſome notion of aſtronomy; that they were acquainted with the points of the horizon, where the ſun ſets in the ſummer and winter *ſolſtice*, and in the *equinoxes*; marks which the Spaniards deſtroyed, as being monuments of Indian ſuperſtition; and it has been aſſerted, that the race of the Incas, who were the deſcendants of Manco, was whiter than that of the natives of the country, and that many of the Royal Family had beards. All or moſt of theſe particulars are European marks; and as Prince Madoc did ſail for America the ſecond time, it is more than probable that he and his wife reached the country of Peru, and founded that great and happy empire.

It is very remarkable, that the people, both of Mexico and Peru, were impreſſed with a ſtrong perſuaſion, that they were ſome time or other to be viſited by a powerful people from the eaſt. This notion was handed down by tradition from father to ſon; and the tradition appears to me to have this origin. Madoc left the Mexicans with a promiſe and full intention of returning to them again; and, therefore, that generation would live in continual expectation of his appearance; but the next generation would only remember what their fathers told them; and the tradition would grow ſtill more dark and uncertain in the courſe of time. When Madoc landed the ſecond time in South America, and ſettled in Peru, he would very naturally imagine, that ſome time or other his countrymen would follow his track.

He could not go back to Britain, having no ſhip, nor tools and artiſts to build one; but he would ſuppoſe, that the curioſity of the Britons would prompt them to ſearch for America, and he would communicate this thought to his ſubjects, which undoubtedly is the origin of the tradition in Peru.

Whatever opinions the world may entertain reſpecting the firſt peopling of America, here is an hiſtorical fact which rationally accounts for the improvements of ſociety and government in the countries of Mexico and Peru, which cannot be contradicted; and, therefore, I am warranted to aſſert, that this is the moſt natural and authentic account of the origin of thoſe empires that has been yet offered to the public. But although moſt of the American tribes ſeem to derive their remote origin from the north-eaſt of Aſia, it is very evident, that the Eſquimaux Indians are of a different race. Their aſpect, diminutive ſize, occupations, and manner of living, diſtinguiſh them from all the other tribes of America.

But in all theſe particulars they reſemble the inhabitants of Greenland. Bold and intrepid at ſea, theſe little men ruſh into the ſtormy ocean of the north, ſingle, in their ſmall canoes, and purſue the herring, the ſeal, and the whale, in all their motions through the polar regions, where other people dare not venture in the ſtouteſt ſhips, and ſeldom leave their prey until they conquer and bring it aſhore. Though weak, half blind, and imperfect upon land, they attack the whale, the morſe, and the ſeal, at the hazzard of their lives, in the moſt tempeſtous ocean in the world, wound them with their imperfect weapons, and bring them on ſhore. Theſe people cover the concavity of their little boats with a ſkin, and make the whole water-tight; and when each man ſits down in his canoe, he ties the ſkin faſt about his waiſt, ſo that no water can enter; and then he rides like a buoy over the dreadful ſurges, with his paddle in one hand, and his fiſh-ſpear in the other, and ſurmounts all difficulties, in procuring food from the ſea, in a country for ever covered with ſnow, where the land produces little or nothing.

The Eſquimaux eats the fleſh of the ſeal and other fiſh, and drinks the oil of the whale, which he alſo burns in a lamp to dreſs his fiſh, and to warm his hut, which is generally as hot as a ſtove.

From theſe characteriſtic features of the Eſquimaux, they muſt have derived their origin from Norway or Lapland. The Norwegians have always been, and they ſtill are remarkable for their intrepidity and ſkill in braving a ſtormy ſea in a ſmall boat; and theſe are the neareſt parts of the continent of Europe to Greenland, and Greenland is near the country of the Eſquimaux, if not joined to it.

I will reſume the conſideration of the mountains of ice and frozen ſnow, after premiſing a few obſervations concerning the borders of the ocean.

The proper adjuſtment or balance of the quantity of the waters of the ocean in all parts of the globe, has been a ſubject of difficult inveſtigation among the learned for ſeveral ages paſt. Naturaliſts ſaw long ago, that ſeveral Deltas were formed and forming in all parts of the world; and that the waters upon the borders of the ocean were continually propelled and driven back from the ancient boundaries of the ſhores, by the new land which is gradually forming; and many weak and ſilly conjectures have been impoſed upon the public, as great philoſophical diſcoveries relating to this ſubject.

Some philoſophers maintain, that the ocean recedes from the land in one place, in conſequence of its making encroachments upon the boundaries of the ſea in another; and this hypotheſis appears to them as an undeniable truth, becauſe they can produce the appearance of ſome little inſtances in point; but theſe apparent inſtances in proof of their hypotheſis are too little, doubtful, and no way correſpondent to the ſubject. Others will have it, that the water of the ocean is continually growing leſs and leſs,—that the ſurface of the ſea, of conſequence, is continually falling lower; and, therefore, is continually receding from our European ſhores. But they give us no ſatisfactory account what becomes of the water that has left us. However, as an infallible proof of the truth of their hypotheſis, they point out to us the ancient ſea-marks on land, from whence, ſay they, the ocean is fallen away.

I will very readily acknowledge, that the marks they ſhew us were once the borders of the ocean; but that period was in the early ages of the world, before the new land was formed by the ſpoils of the mountains in ſuch places, between the old and new flood-marks. It appears evident, from the obſervations which I formerly made, that there have been numerous and extenſive tracts of new land formed in the bays, and upon the borders of the ocean in all quarters of the globe, in places formerly poſſeſſed by the waters of the ſea; and that ſuch new land is continually increaſing in leſſer or greater degrees. Many millions of acres of new land have been thus formed; and the quantity of water which at firſt occupied thoſe extenſive ſpaces, muſt have been very great; of which no good and rational account has been given as yet, by any naturaliſt that I know of. This great quantity of water is to be looked for, and to be found in the accumulated mountains of ice and frozen ſnow, which are continually increaſing in the polar regions, and upon the ſummits of all the very high mountains in the world. I hope, that this account of the matter will not be thought the leſs ſatisfactory, becauſe it is new.

If we take the trouble to conſider this matter attentively, we ſhall diſcover a very exact agreement and correſpondence between the cauſe and the effect, in reſpect to quantity and time, &c. Immediately after the deluge, there were no accumulated mountains of ice and frozen ſnow, nor was there any new land formed from the ſand and ſlime carried down by the rivers; but by degrees the new land began to be formed, and by degrees the water began to be lodged in the form of ice and ſnow in the polar regions, and upon the ſummits of high mountains. The quantity of new land formed in the bays and ſinuſes, and at the influx of all the great and little rivers of the world, and other places upon the borders of the ocean, and in all the lakes and marſhes which have been filled up in inland places, is immenſe; and of conſequence, the quantity of water which originally occupied thoſe places was immenſe.

We cannot explore the icy mountains of the polar regions; but when we conſider, that annual additions have been laid on for ſeveral thouſand years, we cannot help ſuppoſing it to be of very great extent and depth. Reputable navigators aſſure us, that they frequently meet with fragments of ice floating near the iſland of Newfoundland, and other parts of the northern ſeas, of ſuch prodigious magnitude, that they appear like mountains, ſome of them being ſeveral miles in circumference, and near half a mile of perpendicular depth in the water and out of it. Now, ſuch iſlands of ice muſt have broken off by their own weight, perhaps in a warm ſummer, or in a great ſtorm, from the ſkirts of prodigious mountains of ice hanging over the ſea; which mountains might have accumulated in a few years, partly upon the ſea, and partly upon the land, or perhaps altogether upon the ſea, which freezes every ſeaſon near the poles, and eſpecially in ſhallow places; and it is very probable, that ſome parts of thoſe ſeas may continue frozen through the whole length of ſeveral ſucceſſive cold ſummers; and if ſo, the alternate ſhowers of ſleet and rain in ſuch ſummers, would penetrate the great depth of ſnow which fell in winter, and run it altogether into one ſtrong coagulated maſs or body of ice.

Such reflections may give us ſome idea of the polar ſeas; but we can form no better idea of the inland places of thoſe diſmal regions, than to compare them to the higheſt terreſtrial mountains we know of; and by reflecting, that additional ſtrata of ſnow are frequently lodged above one another every year; and from theſe conſiderations, we may aſſuredly conclude, that the height of theſe mountains, or in other words, that the depth of the frozen ſnow muſt be very great. It appears to me more than probable, that there may be in thoſe regions a depth of ſeveral miles of frozen ſnow in ſome inland places at a diſtance from conſiderable open ſeas. We cannot ſuppoſe it leſs than ſeveral miles in depth, when we reflect upon the vaſt quantity of ſnow that falls every year in thoſe regions, and that none of it melts in places remote from the ſea. There may be a partial thaw at ſome chance times for a ſhort ſpace of time upon the coaſts of conſiderable ſeas; but far from the coaſt, the greateſt heat that can happen will have no farther effect than to raiſe a cloud for an hour or two, which will produce a ſhower of ſleet or ſnow; and as ſoon as the whole horizon is overcaſt, the froſt will return, and the former ſhort relaxation will only tend to harden the general maſs, and make it more impenetrable.

I have hinted before, that there is an exact coincidence, agreement, and correſpondence, in all the parts of nature, which throws light upon the ſeveral parts, and enables us to perceive, that they mutually explain and illuſtrate one another, which makes natural hiſtory a pleaſant and a profitable ſtudy.

I have given ſome inſtances of this beautiful correſpondence and agreement in the ſeveral parts of nature; and I advance what I have ſaid about the polar mountains of ice and frozen ſnow, as another remarkable inſtance. Millions of acres of new land are formed from the ſpoils of the mountains in numberleſs places upon the borders of the ocean, and by filling up inland lakes and marſhes all round the globe. The quantity of water which at firſt occupied thoſe maritime and inland places muſt have been immenſe; and there are millions of acres of ice and frozen ſnow in the polar regions, and upon the ſummits of the higheſt mountains, the extent and depth of which we cannot aſcertain; but it is all water, and the quantity is immenſe. The new land formed by the ſediment of the rivers had a beginning, increaſed gradually, and is ſtill increaſing in ſome ſlow degree. The accumulated ice and frozen ſnow had alſo a beginning, increaſed by degrees, and is ſtill increaſing; ſo that as the water is propelled back from the ſhores, by the increaſe of land from the ſlime of the rivers, a proportionable quantity falls annually in form of ſnow in the polar regions, &c. where it is frozen and detained, and by theſe means a perfect equilibrium is preſerved; and therefore, the ſurface of the ocean is exactly of the ſame height now as it was three or four thouſand years ago, which is abſolutely neceſſary for navigation, and for many other purpoſes. Was the ſurface of the ſea to fall lower, as many have aſſerted, our rivers would all become uſeleſs for navigation, as we could not enter them from the ſea. It would, in that caſe, be always like our ebb tides, when ſhallow water, and a ſtrong current, prevents any veſſel from entering the rivers.

On the other hand, was the ſurface of the ſea to riſe higher in proportion as the water propelled back from the ſhore into leſs extent of ſurface, and as more water has been poured into it from the lakes and marſhes which have been filled up, then we ſhould, in a great meaſure, have been deprived of the benefit of the increaſe of ſo much new land; as the ſea, by riſing ſo much higher, would overflow a conſiderable part of it, and of our original valleys. In this caſe, we ſhould hear daily of nothing but inundations, the ſea breaking over its former boundaries, and deluging one part of the world after another, until at laſt all our belgias, deltas, carſes, and low iſlands, would be laid under water. But matters are much better ordered by omniſcient wiſdom for the general good. The ſuperfluous water is lodged at the poles, and upon the ſummits of the mountains, where it accumulates gradually, in exact proportion as new land increaſes. Thus, we ſee that there is an immenſe magazine of water ſtowed out of our way at the poles, and upon the high mountains, in ſituations too cold for the habitation of man or beaſt, where it is piled up upon the dry land in the form of ice and frozen ſnow, which has been accumulating from the earlieſt ages after the flood, and the depth of the maſſes are ſtill increaſing. This metamorphoſed liquid is heaped upon the higheſt mountains, even under the ardent ſuns of the torrid zone. The Cordilleras, and the Andes in South America, are allowed to be the higheſt mountains in the world, and theſe are for ever covered with ſnow. Neither the extent nor depth of the polar regions can be aſcertained, becauſe we cannot explore thoſe diſmal regions; but we can go round the baſe of the Cordilleras, and other high mountains, in the torrid and temperate diviſions of the earth, which may enable us to compute the extent of the ſnow in theſe quarters of the world; but it is out of our power to find its altitude or depth, becauſe we cannot aſcend the ſummits of many of them, in order to examine circumſtances. Not only the ſummits, but the upper regions alſo, and the hollow diviſions of the Cordilleras, and other high mountains, are filled with ſnow. All the upper regions of very high mountains are ſo extremely cold, even under the perpendicular rays of the ſun, that neither animal nor vegetable can live there. All the upper glens and concavities of ſuch mountains are filled up to a level with the ſummits, upon which an immenſe quantity is piled; but to what height above the ſummits, it is impoſſible for us to know. The upper regions of the Cordilleras are perpetually immerſed and concealed in the gloom of thick and impenetrable clouds, which generally hang pretty low down; and although theſe clouds frequently riſe up ſo high as to diſcover the regions of ſnow, yet the ſummits are ſeldom or never ſeen; but if it happens in ſome remarkably clear day, that the clouds are entirely diſperſed, yet the ſummits of the mountains are ſo extraordinarily high, and ſo far removed from the view of man, that perhaps they are not diſtinguiſhable from the apparent void of the etherial regions; and therefore, we have no way of computing the height or depth of the elevated ſnow in the torrid zone, nor of either the extent or depth in the polar regions.

The only ſure data that we have,—the only means that is left us, by which to judge of the quantity of ice and ſnow that is lodged in theſe regions, is to compare it in idea with the quantity of water which has been propelled from the margin of the ſea, from the mouths of rivers, and from lakes and marſhes where new land has been formed, as the one will exactly correſpond with the other. But I need not inſiſt upon this topic.

I have, in my ruſtic manner, produced ſuch inſtances as will throw ſufficient light upon the ſubject to eſtabliſh the fact, and to prove it to the cleareſt demonſtration; and the truth of this part of natural hiſtory is a further proof of a poſition, which has been often recognized in theſe papers, viz. that all things work together for the general good, in the œconomy of the univerſe, to accompliſh the wiſe and benevolent intentions of Providence; and when we can diſcern the clear demonſtrations of conſummate wiſdom and benevolence ſhining brightly in all parts of nature, then phyſics or natural philoſophy becomes the moſt delightful of all human ſtudies.

We have now finiſhed theſe diſquiſitions, and the reſult of them is a clear demonſtration, that America was at firſt acceſſible by land; but that the paſſage was ſoon ſhut up by great falls of ſnow, which in a ſhort time was frozen ſo hard, that it has never ſince been diſſolved; and that this ſnow has been accumulating for about four thouſand years paſt; that the quantity of water which is congealed in ice and ſnow in the polar regions, and upon the ſummits of high mountains, is immenſely great; and yet, notwithſtanding the greatneſs of the quantity of the water thus lodged, the ſurface of the ocean is not fallen lower by the loſs of it, but is now exactly the ſame height as it was four thouſand years ago; the ſpaces which at firſt contained theſe immenſe quantities of water being gradually filled up, and occupied by new land formed of the ſlime of the rivers, which new land has been made upon the borders, and in the bays of the ſea, at the mouths of rivers, and in making inland valleys and plains, where lakes and marſhes had been before, which keeps the ſurface of the ſea always at the ſame height: And when this ſubject is examined, there will be found an exact agreement and correſpondence between the quantity of water, which had been evaporated and congealed in ice and ſnow, to prevent its running down again, and the extent and depth of new land, which has been made in all parts of the earth.

Before I finally diſmiſs this ſubject, I will beg leave to offer a few intereſting remarks about new-formed ſlimy land, and then I will conclude, by ſuggeſting ſome practical obſervations and improvements, with a view of making ſuch new land more ſalubrious, and of more uſe to the intereſts of ſociety and commerce in all parts of the world.

It is generally known to all philoſophers and naturaliſts, that ſwamps, moraſſes, and ſlimy lands emit crude, putrid, and noxious vapours, which prove fatal to the health and longevity of man, and likewiſe of ſeveral other animals; and there is not the leaſt ground to ſuſpect the truth of this poſition. The humid putrified vapours of ſuch places teem with myriads, with clouds of various *animalculæ*, which are the ſource and ſeeds of peſtilential diſeaſes; and theſe ſometimes prove ſo malignant and deſtructive, as to ſweep away almoſt all the human race off the face of the adjacent countries; and even when mildeſt, they are greatly thinned; and thoſe who ſurvive in ſuch unhappy regions of the earth, ſeldom enjoy a vigorous ſtate of health, but pine away under the pernicious effects of ſo bad a climate and atmoſphere. Perhaps, ſuch ſlimy new formed lands, and the extenſive moraſſes which are made by the overflowing and ſtagnations of great rivers, with the putrid dampneſs which is generated in the ſhades of thick and extenſive woods in warm climates, have had greater and more general effects upon the health and longevity of the human race in all countries, and in all ages of the world, than has been hitherto imagined. It was theſe cauſes, joined to a change of food, and the manner of living in general, that gradually brought down the longevity of the deſcendants of Noah, in a few generations after the flood, to the preſent ſtandard.

Moſes tells us, that the inhabitants of the antediluvian earth lived up to a very great age, ſome of them up to near a thouſand years; and he alſo tells us, that there was no rain, that is, no heavy ſhowers in the antediluvian ſtate of the earth; but that a miſt aroſe, which gently deſcended again, and diffuſed its humidity in ſmall particles, which watered the face of the ground like our miſts and dews. Now, if there was no thick and heavy rain, like our rains, in the antediluvian ſtate of things, of courſe the rivers and rivulets would not be ſwelled, nor muddied or diſcoloured, nor could there be any inundations of the flats, to ſpread the ſlime, and form ſtagnant marſhes. A thick miſt would gently water the plants, and, but ſparingly, the face of the ground, like our dews, which would never affect the rivers in the leaſt, nor hardly ever produce any run upon the face of the ground, excepting what might fall from the leaves of trees, which would ſoon be abſorbed in the arid ſoil. Let no man laugh at this as an improbable fiction. From the influence of ſurrounding cauſes, which affect the conſtitution of the atmoſphere, it ſeldom or never rains in Egypt; and it certainly never rains in the plains of Peru, in South America. A thick miſt or a dew is all the moiſture that falls from the atmoſphere in theſe countries. Now, why might not the particular cauſes, which prevent the fall of rain in ſome few countries in the poſt-diluvian earth, prevail over all the countries which were inhabited before the flood? We frequently ſee ſuch miſts as prove refreſhing to the graſs and other plants and vegetables; but we alſo ſee, that they have not the leaſt tendency to ſwell or affect either river or rivulet. There is a conſiderable condenſation of ſuch miſts upon the leaves of trees, and upon the mountains and higher grounds, in which places the water gently and leiſurely ſinks into the earth to ſupply and maintain the living ſprings, which are always pure and undiſturbed, till rain comes to ſwell the currents, and waſh away the ſoil. The antediluvian miſts could only produce ſcanty ſprings, which would collect into ſmall rivers, and theſe would for ever glide gently along, limpid, ſmooth, and undiſturbed to the ocean; and, of conſequence, no new land could be made in the antediluvian earth. There was then no ſwelling nor overflowing of water, and, of courſe, the atmoſphere would not be ſuddenly over-charged with exceſſive humidity, nor with crude and peſtilential vapours. Such a conſtitution of the elements would produce an equable and ſalubrious atmoſphere, undiſturbed by violent ſtorms, and ſudden changes from heat to cold, &c.

Trees and ſhrubs thus watered, and growing in ſuch an equable and conſtant temperature of the air, would produce plentiful crops of wholeſome well-ripened fruits. But this mode of watering the ground was but very ill adapted to agriculture in general. Such ſcanty ſupplies were very diſproportionate to the demands of a thirſty ſoil, and could never give eaſe and ſucceſs in tilling the ground for crops of corn and roots, &c. After the moſt copious dews, the lighter ſoils would remain quite too dry to produce plentiful crops, and the ſtiff and ſtronger ſoils would be ſo very hard and bound, that they could not be worked without the greateſt difficulty; and when worked, they would not produce much without rain. In ſhort, without ſhowers of rain, ſuch as we are bleſſed with in ſummer, to ſoften, meliorate, and fertilize the ſoil, comparative ſterility would continually diſtreſs and fruſtrate the hopes of the huſbandman; and this was really the caſe; for we are told that the earth was doomed to ſterility, to produce "thorns and thiſtles;" and, when tilled, ſhe was not to yield her ſtrength. Indeed ſhe could not, without ſoftening refreſhing ſhowers of rain. The antediluvian Patriarchs groaned under this curſe of the hardneſs and ſterility

rility of the earth; and they had a promiſe, and entertained a full perſuaſion, that they would be relieved from this calamity by ſome great deliverer; and, agreeable to this hope, when Noah was born, they had a ſtrong preſentiment that he was the deſtined perſon who was to bring about the happy revolution which they expected; for they ſaid, "This ſame ſhall comfort us concerning our work and the toil of our hands, becauſe of the ground which the Lord hath curſed." But they were greatly miſtaken with reſpect to the kind and manner of the deliverance; for when it was offered them, it appeared worſe than the calamity itſelf, and none would accept of it but Noah and his family. In this Noah was an eminent type of Chriſt, whom the Jews would not accept, becauſe he did not appear in worldly pomp and grandeur, and propoſe to deliver them from the Roman yoke, and to raiſe the Jewiſh ſtate above all the kingdoms of the world. And the ſame thing happens every day. All nations worſhip the god of wealth and of worldly grandeur. But, however ſtubborn and ungrateful the antediluvian earth might prove to the labours of agriculture, yet a pure, ſerene, and equable atmoſphere, with a diet of milk and vegetables, and the pureſt ſtreams to drink, promiſes health and long life, undiſturbed by malignant diſeaſes and excruciating pains. In the beginning of the poſt-diluvian ſtate of ſociety, there was at firſt but eight perſons in the whole world, and theſe could, and undoubtedly they did, chuſe a ſituation as like the old world as they could find, where they would enjoy pure air and water, remote from the ſtagnations of moraſſes, and the ſlimy mouths of great rivers. It is recorded, that Noah's Ark grounded upon the mountain of Ararat, which is generally ſuppoſed to be a high mountain of Armenia. The country of Armenia is in general either mountainous or hilly, and the hilly parts of that country abound in rivulets, and the ſmall hills and valleys are exceedingly pleaſant, healthy, and fruitful. Noah and his ſons would ſettle for ſome time in this delightful and healthy ſituation, where he would always breathe a pure ſalubrious atmoſphere, remote from the rank exhalations of the plains and humid moraſſes, and from the ſlime, which would be lodged in vaſt quantity by great rivers. It is alſo recorded, that immediately after the ſubſidence of the univerſal deluge, "Noah began to be an huſbandman," and it was neceſſary that he ſhould. It deſerves to be remarked, that this ancient Patriarch always approved himſelf a worthy man, and a friend to ſociety, by doing all the good that was in his power in every ſituation. The inhabitants of the antediluvian earth were univerſally abandoned to extreme and boiſterous wickedneſs. Oppreſſion and violence every where prevailed, and then "Noah was a preacher of righteouſneſs."

The deluge put a dreadful period to the matured wickedneſs of the old world. The Ark was loaded with the precious treaſures which we enjoy; and it ſaved not only the four families of Noah and his three ſons, but alſo all ſorts of cattle, and all ſorts of grain and ſeeds, which would have periſhed in the waters of the deluge. This was the moſt precious freight that ever floated on the ſea, a depoſitum committed to the care of Noah, of great conſequence to the future welfare of the world. The various grains and other ſeeds were all committed to a grateful ſoil, after it had been cultivated and prepared by Noah and his ſons; and the produce of his firſt harveſt would give plenty and variety of food. The various productions of a fruitful country, which was now well watered and refreſhed with plenteous ſhowers of rain, would ſoon multiply exceedingly; and this plenty and variety of all things would cut off all ſhadow of pretence for future oppreſſion and violence; and thus Noah laid the foundation of the virtue and happineſs of the new world in general proſperity, and the enjoyment of plenty and variety of all the neceſſaries and comforts of life, as the fruit and the reward of induſtry.

It is to be ſuppoſed, that Noah and his deſcendants would live contiguous for ſome time among the limpid ſprings in the dry ſoil and pure air of the hilly country of Armenia; and it is alſo to be ſuppoſed, that, for ſome conſiderable length of time, they would lead a life ſomething ſimilar to what they had been bred with in the old world. They had plenty of milk and vegetables, with the beſt of fruits and pureſt water to furniſh the ſame ſort of food, which would have very powerful effects in preſerving health and lengthening out their lives; and the *ſtamina* or anciently good habit of body which they brought with them, and ſtill enjoyed, as yet not much affected by any viciſſitudes or ſhocks of the poſt-diluvian ſtate of the earth, and conſtitution of the air, would alſo have a very great influence upon the longevity of the firſt deſcendants of Noah; and we are told that many of them lived to a great age. But their lives were ſoon ſhortened when they came down to the ſlimy plains and humid marſhes of Shinar, Egypt, &c.

When the deſcendants of Noah were conſiderably increaſed in the countries of Ararat, the good Patriarch would begin to ſend out colonies firſt to the land of Shinar or Babylonia, to Egypt, Syria, and Meſopotamia, well knowing that the whole earth was to be peopled by his poſterity.

Some imagine that Noah finally ſettled in China after the deluge, which I think very probable.

It has been the univerſal experience of all ages and countries, that great proſperity and fulneſs of all things produce idleneſs, and idleneſs a contempt of order, and the regulations of ſociety. Many of the young bucks of the early ages would commence hunters, and hunting is the nurſe and alternative of war. Theſe hunters would poſſeſs themſelves of extenſive territories for the convenience of the chace, and the antediluvian violence would begin to make its appearance again. Nimrod very ſoon began to be a mighty hunter, and a mighty conqueror of extenſive countries, out of which he chaſed the former peaceable inhabitants; "and the beginning of his kingdom was Babel, and Erech, and Accad, and Calneh, in the land of Shinar." A father of virtuous ſenſibility, who has devoted his whole life for the good of his family, cannot live happy with vicious and diſobedient children. A worthy and aged prince, who has conſtantly aimed at the good of his people during a long reign, cannot brook the total loſs of his authority. When the deſcendants of Noah began to deſpiſe and break through his good regulations of ſociety and government, he might ſelect a few of the moſt virtuous and docile, and ſeparate himſelf and his ſmall company from the wickedneſs of the multitude,

titude, which he could no longer controul; and he might travel eaſtward until he arrived in China, in order to be far enough from the wickedneſs and violence of the reſt of his deſcendants. Noah was not the only father whoſe ſoul has been vexed at the diſorders of his family, and filled alternately with indignation and grief at their wickedneſs!

"Noah began to be an huſbandman," but his grand-children began to be mighty hunters and oppreſſors of men, which ſcenes of violence Noah could neither ſuffer nor remedy; and, therefore, he went as far as he could out of the ſight and knowledge of the very ſame evils which had procured the deſtruction of the old world, and ſettled in China, where he had to begin the world anew in his old age. Noah would conſider it as a heavy calamity to be forced at that age to wander from a people, for whoſe happineſs he had done ſo much; but we can ſeldom diſcern the good intentions of Providence in our ſevere afflictions.

Noah was now going to found the moſt induſtrious, the beſt cultivated, the moſt durable, and moſt populous empire in the world. The inſtitutions of the laws of China ſeem to have been founded in agriculture as a broad and ſolid baſis, upon which that extraordinary empire was to be raiſed, and to flouriſh through a length of ages, in ſpite of all the viciſſitudes and ſhocks of time, and of barbarous conquerors. Agriculture is no where honoured as in China, where the Emperor himſelf plows the ground, from which we receive plenty of food, and all ſorts of neceſſaries. Like a good and virtuous father, he gives this beſt precept and example to his children; and there never was a period in the annals of the Chineſe hiſtory, nor in the former ages of tradition, when it was not the cuſtom for the Emperor to hold the plough. No doubt but this was at firſt an unavoidable condition of the dignity, that the firſt in power ſhould be firſt in induſtry, and then the ruler of the people was always the beſt ploughman; and though, in after times, when they became great and wealthy, they began to relax, and at laſt he only plowed one day in the year, yet they ſtill keep up ſo much of the ancient cuſtom, as makes huſbandry more reputable, and in higher eſteem there, than in any country in the world; and, of conſequence, China is far better cultivated, more fruitful, and more populous and wealthy, than any other country upon the face of the earth. This is the fruit of the plans of proſperity and happineſs which Noah laid in his old age, which at laſt proved ſucceſsful.

In that ſtate of induſtry and plenty, which was at firſt eſtabliſhed in China, the human race, and all the uſeful animals, would be as fruitful as their well cultivated country; and, of conſequence, population would make quick advances.

" Noah lived three hundred and fifty years after the flood;" ſo that he had time enough to lay the foundation, and to complete the wiſe inſtitutions of the Chineſe government, ſuppoſing him to live in China only the one half of that period of time. But human perfection is never complete, and but of ſhort duration. The ſeeds of evil are always in our hearts, and they always ſpring up quickly in the luxurious ſoil of proſperity. The beſt laws and wiſeſt regulations of ſociety cannot prevent ſome from tranſgreſſing them. Many of thoſe who are brought up in fulneſs, and carefully nurſed in the lap of proſperity, feel a ſort of ſelf-ſufficiency, and a diſſolute inclination to throw off the yoke of legal reſtraint and obedience to uſeful and ſalutary rules; and as ſuch would ſee room enough, and had no experience nor idea of difficulties, ſome of theſe young bloods of China would ſoon ſet up for themſelves, in a full perſuaſion of arriving at eminence, perhaps at empire, without being confined in the trammels of ſtrict regulations; and they would eaſily perſuade others to be the companions of their adventurous raſhneſs. But as theſe would carry the ſame ſpirit of licentiouſneſs, and ſeeds of diſorder, along with them wherever they went, there was but ſmall hope of their ſucceſs in founding uſeful colonies, and eſtabliſhing induſtrious and well regulated ſocieties. Theſe were already tired of the patient and orderly occupations of tilling the ground; and, therefore, they would ſoon commence the ſavage or ſylvan life of hunting and fiſhing, and feeding a few cattle; and many of them would idly roam about in ſearch of ſuch ſpontaneous fruits as the woods afforded them. This claſs of people would degenerate by degrees into abſolute ruſticity and barbariſm, and their immediate offspring would be taught nothing in the world but the uſe of the bow and of the club. This is the origin of the hordes of wandering Tartars, and even of the Americans, who deſcended from the north-eaſtern Tartars; and this may ſufficiently account for the profound ignorance and barbarous ſtate of all the aboriginal ſylvan tribes, who live by hunting and fiſhing.

Our modern philoſophers may make a parade of their learning and ingenuity, as long as they pleaſe, in building the ſcale or gradation of the advances of man from the ſavage to the civilized ſtate, but it is all in their own imaginations and ſyſtems; for man by nature never advances one ſtep towards a civilized ſtate of ſociety and induſtry; on the contrary, untutored man, of himſelf, goes backwards, and degenerates from the civil to the ſavage ſtate. The Tartars laid the foundation of their perpetual hordes in idleneſs, ignorance, and ſavage ruſticity; and they have never tilled the ground, nor ſought after any uſeful knowledge, though they know well enough where to find it, being ſurrounded by civilized nations.

It is a curious amuſement to trace out the ſedulous labours of a number of modern philoſophers, carefully following one another's footſteps in diſcovering the origin of Man, like the monkey in the woods, and gradually leading him by very ſlow degrees from the ſavage or ſylvan ſtate to the civilized, when there is no ſuch thing in nature. What a world of knowledge, penetration, and judgment they diſcover, in tracing out and deſcribing a mock hiſtory of what never happened in the world, nor ever will! Man, in a ſavage ſtate, never, of himſelf, advances one ſtep towards the civilized, nor never will, without ſome remarkable revolution, or the application of ſome powerful external ſpring or impulſe, to perſuade or force him to a change of life; and I believe it muſt be force. Much perſuaſion and force have been employed to reform the ſavages of many countries; but it has always been experienced, that ſo ſoon as the force of the impulſe was removed, which excited any of them to an apparent compliance with the rules of ſociety, whenever the ſpring was relaxed, they always returned immediately to the ſavage ſtate and ſavage life. The various tribes or wandering hordes of Tartars, poſſeſs an immenſely extenſive country of ſeveral thouſand miles in length from eaſt to weſt, and of very great breadth, all of it ſituated in the northern temperate zone; yet thoſe vaſt regions of the earth have never been cultivated. Though the Tartars have as rich and fertile ſoils, and as fine climates as any in the world, theſe fine countries have never been diſturbed by the plough nor the ſpade. So far are theſe hereditary barbarians from any advances towards a civilized ſtate of improvement and induſtry, that they burn the luxuriant crops of graſs off their fertile plains, when it begins to wither in the latter end of ſummer; and this barbarous ſavage practice they continue to this day, becauſe they will not take the trouble to cut and preſerve it for their cattle; and they find a freſh growth in ſpring from the aſhes of the laſt crop, which acts as a rich and powerful manure.

The Tartars are now in the ſame ſavage ſtate as they were four thouſand years ago. They have frequent communication with the Chineſe, Perſians, and other civilized nations, and know their manner of living, but they like their own much better; and nothing in the world could perſuade them to change their own cuſtoms. They prefer a piece of horſe's fleſh, delicately prepared by animal heat between their own buttocks and the living horſe's back, to the beſt cookery of their neighbours. The native Americans derived their remote origin from the north-eaſt of Tartary, as was clearly proved above, and they ſtill retain much of their original character. Neither precept nor example will induce a North American to ſubmit to the civilized regulations of ſociety and government. He always prefers his own way of life to all others, though he is generally in want of all things, and ſees the plenty and variety of the comforts of life which the Europeans enjoy. They ſtill remain perfect Tartars in both continents.

The Caffres, and all the other ſavage tribes in the ſouth of Africa, are much in the ſame ſtate as the Tartars and Americans. None of all theſe ſavage tribes advance one ſtep towards civilization. Though Chineſe, European, and Arabian traffickers, have been a long time among the ſavage hordes of Aſia, Africa, and America, yet none of them have been induced to change their ſtate. The civilized have not been able to reduce the number of ſavages without killing them. But, on the contrary, the number of ſavages have been increaſed in many parts of the world within the ken of hiſtory. Several Arabian tribes, who have wandered into the wilds of Africa, have loſt all marks of civilization, and are become as ſavage and barbarous as the Aboriginal Africans.

Our modern philoſophers have really taken the wrong ſide of the queſtion; as it is evident, from the annals of the world, and from the nature of things, that man naturally degenerates, and without ſome powerful impulſe to propell and force him forward, he will never advance a ſtep towards civilization.

He has been accuſtomed to roam about as chance or inclination led him, in ſearch of his food and of his pleaſure,—he has always found ſome ſort of ſubſiſtence in this ſtate and courſe of life, and this he likes beſt, from cuſtom, example, and long habit; and therefore, he would rather ſuffer death than be always confined to the laborious cares of huſbandry, and be bound by the ſtrict regulations of ſociety. Eſtabliſhed habits are not eaſily eradicated. The civilized philoſopher can hardly conquer them; how then can we expect that the ſavage will leave his old habits which have taken root for ages; and eſpecially when he has what he thinks reaſon on his ſide, viz. the immemorial example and cuſtom of his anceſtors, who have all of them lived in the ſame manner.

The ſavage ſtate is from the beginning a ſtate of degeneracy from choice; and when mankind from choice degenerates to the ſtate of the beaſts that periſh, he never will recover from it in any length of time, but will degenerate more and more, and his habits and liking will take deeper root, and increaſe for ever. His indolence, his independence, and roaming way of life is pleaſed with it, and the example of his anceſtors confirms him in it, and he will be confirmed more and more to eternity, without ſome remarkable revolution,—ſome mighty impulſe to force or captivate the mind. They like their own ſtate better than any other, and they glory in it, and deſpiſe the Europeans, and all others, with all their conveniences and regulations of ſociety. They plead with force of argument and a plauſible ſhew of reaſon, in favour of their own way of life. They call the civilized man a ſlave, and expreſs the utmoſt contempt for his variety of food, his delicate cookery, and ſplendid furniture, and fly from him to their woods, where they follow their own inclinations; and imagine, that they are not miſerable, becauſe they have no reliſh for ſocial happineſs, on account of their powerful and unconquerable averſion to its rules and labours. The Chineſe induſtry, wealth, and ſplendour, has only attracted the attention of the Tartars to rob them when they were able, but never to follow their example.

The Negroes and Caffres of Africa have not been induced by any means to lay down the bow and take up the ſpade, ſince they have had the example of European induſtry and plenty.

The North American provinces are well cultivated; and the ſavages are every day in the cities and villages, where they often taſte of the variety and plenty of food which our people enjoy; and they ſee that our people are well cloathed, well lodged, and enjoy abundance of all things, but the example has no effect.

The ſavages with joy return to their woods, and conſider themſelves free men, the only dignified character and happy ſtate in the world, and they look upon our people as miſerable degraded wretches; ſlaves doomed to work and to obey the will of another, which they conſider as worſe than death; and the example of near two hundred years has not altered their opinions in the leaſt.

How vain, then, and futile are the ſyſtems of our modern philoſophers, about the ſlow but gradual advances of all nations from the ſavage to the civilized ſtate! which notion is now become a canting phraſe among the learned, but the real progreſs is retrograde. Without line upon line, precept upon precept,—without conſtant inſtruction and example, with the care and exertions of government and police, man will degenerate from the civilized to the ſavage ſtate, of which the banditti of all ages and countries is an irrefragable proof; but man, without ſome irreſiſtible impulſe, never advances a ſtep from the ſavage to the civilized ſtate. But to return from this digreſſion.

When the poſterity of Noah were ſo multiplied as to be able to ſend out many regular colonies, ſome of theſe colonies would chuſe to ſettle in rich plains upon the fertile banks of great rivers, in the neighbourhood of moraſſes, and of the ſlimy mouths of the rivers, where, by this time, plenty of new land was formed. In theſe ſituations they would find the lands eaſily cultivated, and their crops would be rich and luxuriant, which ſoon determined them to build cities, to form regulated ſocieties, and at length to found empires in ſuch places; but they had not then philoſophy nor experience enough to perceive that they were in the near neighbourhood of death. As the ſoil of theſe valleys and well watered plains was rich and fertile, perhaps they would never reflect, that the damp and putrid exhalations of the moraſſes, and of the ſlime, was peſtilential to the human frame; and yet it is certain, that ſuch ſituations and countries would grow worſe and worſe as new land was increaſed upon the margin of the ſea, and by filling up ſhallow lakes in the courſe of the rivers. In proportion as new land was formed in the courſe, and at the mouths of the rivers, the channels or beds of theſe rivers would fill up, be ſtraightened, and grow ſhallower in many places, which would occaſion ſuch inundations in the rainy ſeaſons, or after the melting of ſnow upon the mountains, that many extenſive new formed plains would be laid wholly under water; and theſe inundations would increaſe the evil, by forming moraſſes, and leaving a putrid ſlime upon the face of the ground.

Thick and impenetrable foreſts would ſoon overſpread extenſive countries and diſtricts in the early ages of the world; which would prove plenteous ſources of putrid and unwholeſome vapours. Theſe multiplied and united cauſes of ſickneſs and diſeaſe, would ſoon taint the blood, and affect the conſtitutions of the inhabitants of the valleys and plains, to ſuch a degree as to ſhorten the former period of life. The inhabitants of the plains would intermarry with thoſe of the hilly countries; and thus, by frequent mixing, they would in the courſe of time become all one maſs. The inhabitants of populous cities would ſoon grow wealthy by commerce, and then they would learn the arts of luxury. The ſimple diet of their anceſtors would then be changed for animal food and fermented liquors. Theſe ſeveral cauſes collectively would, in the courſe of four or five hundred years after the flood, make a total change of the conſtitution of the body of man, and bring it down to the preſent ſtandard of longevity, which has been very near the ſame for more than three thouſand years paſt.

The damp, crude, and putrid ſoil upon the humid plains, in the courſe of the rivers of the world, and at their influx to the ſea, is perhaps the moſt general and the moſt durable calamity that ever afflicted the human race; but this great evil always has been, and it ſtill continues to be their own fault. This greateſt and moſt general of all evils might have been made the greateſt good in many parts of the world. By proper care, by proper plans of improvement, and well directed induſtry, millions of acres, which really are the abhorrent nurſeries of diſeaſes, pain, and death; where their ſqualid and peſtiferous armies are muſtered, and from whence they ſpread over the face of the earth to torment and conſume the children of men, might have been the happy ſcenes of health, plenty, and vigorous felicity.

Had the kings of armies, and governors of the world, employed but the twentieth part of the people, and of the treaſures which they conſumed upon unjuſt and uſeleſs conqueſts, and upon cruel, capricious, and unjuſt wars,—had they employed them in draining the moraſſes, in thinning the woods, in improving the beds and the bars of rivers, in giving encouragement to agriculture, and improving the waſte lands of their dominions and governments, what a happy world would this have been, in compariſon of what it really is, and always has been, from the earlieſt ages!

All Aſia and Africa might have been a rich and delightful garden, like China, ſwarming with healthful, induſtrious, and well regulated societies, and teeming with plenty and variety for their ſubſiſtence. But man is mad, and ſeldom ſtudies his true intereſt, or acts with juſtice and probity. A capricious fancy—an idle empty whim—a trifling or malevolent intention, takes poſſeſſion of the whole man, and hurries him forward with impetuoſity to commit the ſtrangeſt abſurdities, and the moſt horrid crimes, through the whole courſe of his life, without looking back, or aſking himſelf the queſtion, what he is about? What multitudes of armies, what miriads of the human race, have been led out by ſuch fools and madmen to plow the main, or to force their way through putrid deſerts, or over impaſſable rocks, to be afterwards buried in the peſtilential camp, or in the ſanguine field of battle!

How I honour and revere the Chineſe Legiſlators—who have ſhunned war—who have taught their people the arts of peace—who have made their rivers the marts and the commercial roads of communication to all parts of their vaſt empire—who have made their cities work-ſhops and granaries, and the whole face of their extended empire, at once a populous town, a flouriſhing manufactory, a rich corn field, and a delightful garden! How widely different are theſe wiſe, peaceable, and induſtrious leaders of mankind from the mad and cruel maſters of the world, who have neglected agriculture and all the arts of peace, but have increaſed the morbid fens with the blood of their own, and their neighbour's ſubjects.

Holland and China are inſtances in proof of what other marſhy grounds might be made; and yet it is aſtoniſhing to reflect what prodigious extents of the richeſt ſoil in the univerſe is ſoaking in fetid moraſſes, or fermenting in the putrid effects of its own fertility, and filling the atmoſphere far and wide with ſickneſs, pain, and death, which is carried far upon the wings of every wind.

It is not eaſy to conceive an adequate idea of the prodigious extent of new land which is formed in the courſe and near the influx of all the rivers of the world. If we ſhould take a curſory view of the Rhine, and other rivers, which have produced the Netherlands, of the Danube, and other great rivers of Europe, we ſhall find a conſiderable extent of new land formed in this leaſt quarter of the globe; but when we ſurvey the Ganges, Wolga, Indus, Ava, Pegu, Cambodia, Petſho in Nankin, the Oxus, Oby, Euphrates, Tigris, and other great rivers of Aſia, which are very numerous, and then join to theſe the Nile, which has produced moſt of Lower Egypt, the Senegal, Cuama, Zair, Niger, and other great rivers of Africa, we ſhall find the quantity and extent of new land formed by them upon the Old Continent to be immenſe.

Let us, in the next place, caſt our eyes over the map of America, and take a view of the rivers Plate, Amazons, St Francis, Torantis, and other great rivers of South America, and of the rivers Miſſiſippi, St Laurence, Oroonoko, North Colorado, Suſquehana, Hudſon's, Charles's, Delaware, with the other large and very numerous rivers of North America, and we ſhall be led to believe, that there is as much new land formed by the ſubſidence of the rivers in the New Continent as in the Old. Some of the mountains of the New Continent are much higher than thoſe of the Old; and it is from the mountains that all the great rivers of the world derive their ſources; and it is with the decompoſed ſpoils of the mountains, and higher grounds, which the rivers carry down, that new lands are formed. The rivers of the New Continent are as much larger than thoſe of the Old, as the mountains are higher. The remoteſt ſource of the river Plate is two or three thouſand miles from its influx. Several of its branches are prodigious rivers, of which the

Paraguay is the chief. They are collected off the ſurface of a vaſt extent of country; and when they are all joined together, the Plate is liker a ſea than a river, where it falls into the ocean. The river Amazons is ſtill larger than the Plate. It derives ſome of its numerous ſources from the Cordilleras, and ſome of them from the Andes, which are the higheſt ranges of mountains in the world. This immenſe and magnificent river is like a ſpreading wall-tree, which ſhoots out a great number of large and ſtrong branches on every ſide. The principal river, and moſt of its larger branches, traverſe vaſt and extenſive plains, which are frequently laid under water by the united inundations of ſo many great rivers ruſhing down from ſuch lofty mountains, ſituated in the moſt rainy part of the globe. The river of Amazons is ſaid to be much above three thouſand miles in length, to contain a great number of iſlands in its courſe, and that it is about a hundred and fifty miles broad where it joins the ocean.

The river Miſſiſippi in North America, though not quite ſo large as the rivers Plate and Amazons, ſeems to have a much longer courſe than either of them, and to collect its ſtreams off as great an extent of ſurface; but the mountains of North America are not ſo high as thoſe of South America, which is a very good reaſon for the rivers not being quite ſo large. The remote branches of the Miſſiſippi derive their ſtreams from unfrequented deſarts far to the weſt of Canada, which have never yet been thoroughly explored by any Europeans, ſo that the real length of this great river cannot be exactly aſcertained; but it appears highly probable, that the length of of it from the ſea to the ſource of the furtheſt branch, is not leſs than four thouſand miles.

The great river St Laurence, in North America, ſeems to be under the ſame predicament as the Miſſiſippi, with reſpect to the knowledge and diſtance of its remoteſt ſources, which are ſituated ſomewhere in diſmal regions to the north-weſt of Canada, little, or perhaps not all, frequented by Europeans.

The Oroonoko is another vaſt river of North America, which derives ſome of its ſources from the lofty mountains which are ſituated under the line between New Granada and Peru. We are informed, that this great river begins to ſwell in the month of April, and continues to increaſe during five months, when all the fertile plains upon its banks are laid under water. It is very evident, that the rainy ſeaſon under the line, and the melting of the ſnow by the rains, and by the advancing of the ſun towards the north, and returning ſouth again over the line during theſe months, is the cauſe of theſe periodical inundations; and the inevitable reſult or conſequence of theſe floods will be, that all the plains and low lands upon the banks of this great river will be ſlimy, marſhy, and unwholeſome, during the greateſt part of the year, which is a particular misfortune, as moſt of the lands bordering upon the Oroonoko are ſaid to be remarkably fertile.

From this very curſory view of the great rivers of the world, it appears very evident, that the quantity and extent of new land gradually formed by the ſediment of the rivers filling up lakes, and enlarging the ſhores of the ocean, muſt be exceeding great.

I am of opinion, that if all the Deltas, all the moraſſes and humid valleys, and other parcels of new land, were drained and improved to the higheſt degree they are capable of, they would be abundantly ſufficient to maintain as great a number of inhabitants as there are now upon the face of the earth; ſo that, upon this ſuppoſition, the human race now actually exiſting upon the whole face of the earth might be doubled, and there would be abundant proviſion for them all; and, therefore, if this ſuppoſition is founded in truth, it merits ſerious enquiry, whether or not the thing is practicable? If there are ſuch immenſe tracks of the richeſt ſoil in the univerſe lying dormant and uſeleſs, what can be more intereſting than to know if it is poſſible to recover all this precious treaſure?

Nothing appears to me more evident, than that all or moſt of it may be recovered and improved to be the moſt valuable and moſt commodious land in the world; and, moreover, ſuch improvements would bring health, plenty, and joy to thoſe miſerable regions, where ſickneſs, want, and gloomy melancholy now reign uncontroulled from age to age.

When ſuch prodigious tracks of land, in all parts of the world, have been allowed to lie in a marſhy and chaotic ſtate hitherto, breeding fetid and peſtilential vapours, it may be thought by ſome, that ſuch places are not improveable, otherwiſe that ſuch improvements would have been accompliſhed long ago; and, therefore, they will think that I have been betrayed, by a fondneſs for the marvellous, to be guilty of a very raſh aſſertion. There have been ſuch great works undertaken and accompliſhed in ancient times in many parts of the world; theſe have been the wonder of all ſucceeding ages; and, therefore, it is not to be ſuppoſed, that the improvements above ſuggeſted are impracticable, otherwiſe they would have been performed, as there have been men of genius and enterpriſe in all ages, and in all countries, and eſpecially in all the parts of the Old Continent, which were formerly enlightened.

I will readily acknowledge, that I have made a bold aſſertion; but I will endeavour to prove that it has not been raſh. Aſk the Dutch and Chineſe, eſpecially the laſt, whether the thing is practicable or not? The United Provinces of the Netherlands are entirely founded upon the ſlimy ſediment of the Rhine, and other rivers; and the whole empire of China is like a well cultivated garden, without any waſte land of any ſort, tho' much of it was at firſt marſhy and ſlimy, and overflowed by the tides, which is a proof that the thing is practicable.

Moſt of the great works that have been performed in ancient times, were marks of vanity and oſtentation, which were raiſed high above the ſurface of the ground for the gaze and admiration of the world. The liſt of great and uſeful works, planned and executed for the general good of ſociety, is but ſmall. Some little, it muſt be acknowledged, has been done in later ages, by a few commercial nations, for the convenience of mankind, and furtherance of navigation and commerce.

The reſt of the world preſents almoſt an univerſal blank, with reſpect to great and uſeful works for the laſting benefit of mankind, China always excepted. Great monuments of oſtentation are to be met with in many parts of the world, which have been celebrated and admired through a length of ſeveral ages.

As a further proof that the above aſſertion is not raſh, but reaſonable, I will ſuggeſt a few hints concerning the means and methods how ſuch great and ſalutary advantages can be attained, as to double the means of ſubſiſtence, and to double the health and happineſs of many and extenſive regions of the earth; and, in purſuance of this deſign, I will begin with the rivers.

The fertile banks of great rivers have always been the delighted haunts of ſocial induſtry; and it is generally in theſe ſituations that we meet with the arts and with commerce, plenty and wealth; but the greateſt number of the largeſt rivers in the world are now under the dominion of the peſtilence, &c.

Let us deliberate a little upon the means of driving theſe ſqualid enemies of the human race away from their ancient reign. If we are friends of mankind, we cannot be better employed. The Dutch and Chineſe have ſhown us what banking and ſluicing will do; and their method is ſo well known, that I will not loſe time with it. But I do not approve of the practice of banking rivers, excepting only where the tide is concerned. We are obliged to raiſe banks to keep out the tide, which overflows ſuch land near it, as only appears from under water the greateſt part of every day.

It generally happens, I may almoſt ſay that it univerſally happens, that the beds and banks of great rivers are already too high, eſpecially in the low plains and valleys, and near their influx to the ſea ; and, therefore, it would be prepoſterous to raiſe them higher by banking, notwithſtanding the ſanction of cuſtom. Where new land is formed by great rivers in level plains, and near the ſhores of the ocean, the preſent banks, and ſometimes even the beds of the rivers, are higher than part of the plains, and moſt of the moraſſes, upon both ſides of them ; and, therefore, to bank them would be to enlarge the collateral lakes and moraſſes, which are ſituated without the banks, and to prevent the water of them from returning at all into the channel of the river again ; of conſequence, our buſineſs is to ſink the bed of the river ; and when the bed of the river is ſunk ſufficiently lower than it was before, we then facilitate the draining of the moraſſes and damp land upon both ſides, make it fit for any manner of culture, and inſure the crops from being deſtroyed or hurt by future inundations.

Before we point out the manner and method of deepening the beds of rivers, it is neceſſary for us to examine a little what ſort of matter the beds of them are compoſed of. In general, the beds of rivers may be divided into three different ſorts or ſpecies, viz. 1. ſuch as are ſandy and ſlimy; 2. ſuch as are gravelly; and 3. ſuch as are rocky. Each of theſe diviſions will require, in ſome particular reſpects, a different management in ſinking the beds of the rivers. I will begin with,

I. The ſandy and ſlimy beds.—Nothing has a greater tendency to haſten the choaking up and raiſing the ſlimy beds of great rivers than drift-wood. In the rainy ſeaſons, which commonly is the time when the greateſt quantity of ſnow is diſſolved among the lofty mountains of the torrid zone, and other places, the land floods are then ſo very great, that the banks of the rivers are undermined, when great pieces of land ruſh down, trees and all, into the floods.

In theſe ſeaſons, great numbers of the largeſt trees in the world will be driven forward by the prodigious force of mighty torrents, until they arrive at the plains, and there they will be lodged and entangled in all directions, both in the bed of the river by the way, and alſo near the bar or influx with the tide, in the countries of America, Africa, and other places; and the ſand and ſlime gather about theſe entangled trees, and ſoon raiſe the bed of the river higher than the plain or new land, ſometimes upon one, and frequently both ſides; and when the river is thus raiſed higher than the collateral plains, it will of neceſſity deviate from its former courſe, and form new channels; and theſe new channels will be choaked up in their turn, and others made one after another in the courſe of time; and this undoubtedly is the origin and natural cauſe of great rivers entering the tide by many mouths.

Now, it appears to me, that there are only two great operations to be performed in order to deepen the bed of this ſort of river. The firſt is, to collect and confine the ſeveral ſtreams and mouths of the river into one channel; and the ſecond is, to take all the roots, trees, and other obſtructions out of that channel; and then the weight and force of the united and confined ſtream will carry away the ſand and ſlime along with it into the ocean.

When theſe two arduous taſks are performed, the ſandy and ſlimy river will deepen of its own accord. If once the trees and other obſtructions are taken out of the channel, the weight and force of the united ſtream of a great river will ſcour away the ſlime with eaſe.

Let us now conſider how theſe two great branches of work are to be performed: With reſpect to the firſt, that is the collecting of the ſcattered branches of the river, and confining them in one, it is very difficult to point out with preciſion the method that ſhould be followed in different places, as circumſtances will vary conſiderably; and therefore, we ſhould alſo vary the method, in order to follow nature, which will always be found to anſwer beſt. However, we may ſuppoſe it will frequently happen, that the beſt way to collect the ſcattered ſtreams at the mouths or influx of rivers, and confine them to one channel, will be, to drive in two rows of piles upon each ſide of the river, leaving a proper and ſufficient ſpace between them; theſe rows or lines of piles to be ſtrongly wattled or woven with long branches, or with under-wood, of a tough and durable quality, the ſmall ends or grains of the wattling to come out next the river, and to go or lean with the ſtream of the water. The two rows of piles upon each ſide of the river muſt be wide or narrow; that is, the ſpace between the two rows or lines muſt be wide or narrow, in proportion to the magnitude and force of the river; and the piles muſt alſo be proportioned to the weight and force of the ſtream which they are to confine.

The ſpace between the two rows of piles upon each ſide of the river muſt be filled up with earth, &c. dug out of the new channel of the river, and raiſed at leaſt as high as the piles and wattling; and if turf can be had, eſpecially marſhy turf, I apprehend, that the inſide of the row or range of piles next the water, oppoſite the old channels of the ſcattered ſtreams, ſhould be lined with a dyke or wall of turf well built, and beat ſtrongly together, ſo as to keep out water.

When the ſpace between the lines of piles upon each ſide of the river is filled up as high as the upper edge of the wattling, then let it be ſtuck full of ſtrong aquatic plants. The piles ſhould alſo be made of aquatic plants or trees, and the bark left on them, to the end that they may take root, and grow up along with the ſtrip of planting within the rows of piles.

Without the tropicks, there are but few plants that exceed the willows, for taking root and growing haſtily in water, and in all wet places; and moſt of the ſpecies of willows produce a congeries of roots, which are admirably adapted for reſiſting and turning water. There are generally abundance of mangrove trees in moſt of the rivers between the tropics. A broad row of mangroves, or other large and ſtrong aquatic plants, well grown upon each ſide of a river, will at once be a very beautiful, and a very effectual method of confining a river within the lines which are made for that purpoſe. Such aquatic trees as ſtrike their roots deep, or that have a thick congeries of roots like the willow, ſhould be the beſt for this purpoſe.

The magnitude of the river, even in the greateſt inundations, muſt be conſidered in forming theſe lines. It is abſolutely neceſſary to leave ſufficient room for ſuch a body of water to paſs through, without riſing ſo high as the upper edge or top of the piles and banking; and therefore, the diſtance between the lines for the channel of the river, muſt every where be in proportion to the magnitude of the river at its greateſt ſwell.

But it is proper to remark, that too much room would be nearly as bad as too little. In too much room, the river, when low, would be apt to ſcatter within the lines; and of conſequence, the ſtream would not be ſo deep and convenient for navigation. I imagine, that the beſt rule we can have for judging of the proper diſtance between the mural lines for the channel of the river, will be the real breadth of the river, where it is actually confined between its own natural banks.

In order to find out this real breadth, you muſt go up the river until you find it thus confined between banks upon both ſides, even in the greateſt floods. Examine how wide it is in ſuch a place, and how deep in dry weather when the river is low; and from the knowledge of theſe circumſtances, you will be enabled to judge what ſpace or breadth you ſhould leave between your lines for the collected ſtream of the river.

Where circumſtances will allow it, as great a length of the river as poſſible ſhould be made to run in a ſtraight line. An artificial curved line or courſe for the channel of a river would be a very bad one; becauſe a heavy ſtream of water ſtriking againſt a bank in any direction, would undermine and bring it down; whereas, it ſlides by ſmoothly when the river runs in a ſtraight line, eſpecially if the deepeſt part is in the middle. There are generally large extenſive plains between the influx of great rivers, and the mountains, or any conſiderable riſing grounds; and the greateſt part of theſe maritime plains, upon both ſides of the rivers, is new land, formed by the rivers from the ſpoils of the mountains. A ſtraight line ſhould be drawn for the artificial channels of the rivers, through the whole length of theſe plains, between the riſing grounds and the ſea, or at leaſt ſo far up as they begin to branch. When the courſe of a river is thus ſtraightened through the plains, it will be a great advantage to navigation, and alſo a great ſafety to the lines, which are formed to confine the river in one channel.

When the ſcattered branches of the river are brought to run all in one channel, the united ſtream will waſh the ſand and ſlime off the drift-wood which is buried in it, and diſcover where and how it lies; and when it is diſcovered, it will be neceſſary to get it out, in order to deepen the channel of the river. We muſt now conſider how this arduous taſk is to be performed.

For this purpoſe, it will be neceſſary to build a flat or ſquare bottomed barge or float, the ſize of which, muſt be proportioned to the ſize of the trees, and the ſuppoſed difficulty of drawing them out. This floating veſſel may be either made of a ſquare, or of an oblong ſquare form, though it ſhould not be above eight or ten feet more in length than in breadth. It muſt be built very ſtrong, and particularly, there muſt be a ſtrong beam right acroſs the middle of it below, in which beam a large ſocket of braſs muſt be ſunk, to receive the pivot or end of a large iron gudgeon. The ſides and ends of the float ſhould be raiſed from five to eight or ten feet high, in proportion to the ſize, and then it muſt be covered with a good ſtout deck. A winch, crab, or capſtane, muſt be erected in the middle of this float; the beam or axle of which requires to be very ſtout, with a ſtrong gudgeon in the lower end of it, which is to move in a ſocket in the ſtrong beam at the bottom of the veſſel. The upper end of the axle muſt come up through the deck, where you muſt build very ſtrongly about it, and yet ſo as to allow it to turn about freely. This windlaſs or capſtane muſt be turned about with four, five, or ſix large and ſtrong capſtane bars or levers. The length of theſe bars muſt be regulated by the length of the veſſel; ſo that when a man goes round at the extreme end of one of the bars, he goes cloſe to the head and ſtern of the veſſel; and if it is not built ſquare, but longer than it is broad, then a ſtage or ſcaffolding muſt be erected upon both ſides of it, in order to bring the upper deck to be as broad as it is long, and then the men can go quite round at the farther ends of the levers without ſhortening them. The barrel or axle of this winch muſt be fitted for winding a ſtrong rope about it, both above and below the deck, if it is found neceſſary and convenient. When you go to work with this float, you muſt moor it at ſome diſtance upon one ſide of the middle of the channel, where you are going to draw the trees out of the bed of the river. If you have dry land near enough upon the far ſide of the float, it may be moored by driving poles into the ground and faſtening ropes about them; but if the dry land is too far off, then you muſt moor it with a couple of anchors. If it is not moored ſtrongly, the capſtane will draw the float to the tree, inſtead of drawing the tree to the float. When the trees to be drawn out of the bed of the river are large, the capſtane rope muſt be ſtrong; and ſometimes it will happen, that ſome part of a tree will ſtick faſt in the mud or ſand, which will greatly increaſe the reſiſtance; and this circumſtance requires the rope to be ſo much the ſtronger. Proper grapnels muſt be fixed at the end of the rope, ſufficiently ſtrong and well conſtructed to lay hold of the trees, and there ſhould be grapnels and ropes of ſeveral ſizes.

When there are large and heavy trees lying faſt in the mud, it will require a large float, a ſtrong winch, and a ſtrong rope and grapnels, to move the trees from their beds in the mud; but when a large tree is once moved and drawn looſe, the big rope and its apparatus, being unweildy, may be taken off, and a leſſer one employed to draw the trees aſhore. I ſuppoſe, that it will be neceſſary to have a port-hole in the ſide of the float, immediately below the deck, for the rope to paſs through from the capſtane-axle; and there muſt be a roller made to turn under the rope at the port-hole, to prevent the rope from chafing.

When ſome trees are drawn out, the ſtream of the river will diſcover more; and in order to procure a ſtream or current of water, to ſcour away the ſand and ſlime off the trees, it will be proper to begin at the mouth of the river, becauſe you are ſure of having a current there when the tide is out. The veſſel is either always afloat, or elſe once every tide at high water; and, therefore, it can be ſhifted a little up the river at pleaſure. I ſuppoſe, that it will be proper to take out the timber which appears upmoſt firſt, without endeavouring to get at what lies deeper down; and when you have gone over it all once, as far up as circumſtances require, then come down, and begin again at the mouth or influx of the river, and go over it a ſecond time, and as often again as may be judged requiſite and neceſſary to ſink the bed of the river to the full depth it is capable of. During the time of this operation, care muſt be taken in the wet ſeaſons to keep the river from overflowing its new banks; and if it can be kept within the lines or artificial banks, the floods will do much more good than harm to the operation of deepening, as the weight and force of ſuch a vaſt body of water will ſcour away the ſand and ſlime, which will facilitate the cleaning of the channel from every obſtruction.

When the bed of a river is cleared to the full depth which the tide will admit, it will then be proper to make collateral cuts through the lines or artificial banks upon both ſides, in order to drain and improve the land, which is now ſo far laid dry, that it will not be overflowed by the river any more; and if any part of the land next the ſea ſhould be overflowed by the tide at ſome of the former mouths of the river, before all the branches were collected into one, it will be neceſſary to uſe proper means, by banking or otherwiſe, to keep out the tide in ſuch places from overflowing large pieces of good land, about which I will not pretend to give any directions, becauſe circumſtances will vary leſs or more in every different place; and, therefore, no general directions will ſuit all places.

It is only ſome of the ſalt marſhes next the ſea that will require banking to keep out the tide: All the fens and ſwampy lands further up the river will, I ſuppoſe, be conſiderably higher than the ſurface of the river, at all times, when the bed of the river is ſunk low enough; and, therefore, the improvement of thoſe fens will be an eaſy taſk when the improvement of the bed of the river is compleated. As few cuts as poſſible ſhould be made through the new and artificial banks of the river, and any that are made ſhould be well ſecured, to prevent the ſtream from waſhing away any part of the lower angle or corner of the canál.

If any trees ſhould prove ſo large, and ſunk ſo faſt in the mud, that they cannot be drawn out with the winch, it may in that caſe be neceſſary to cut them in the water, and draw them out piece-meal. A ſpecies of ſaw may be contrived for that purpoſe, to croſs-cut a tree under water.

This may frequently be found neceſſary where ſome of the trees are large and long, and entangled in the mud by the roots, and many ſpreading branches.

II. I will now give ſome directions for deepening the gravelly beds of rivers.—The ſame river may have a bed of ſand and drift-wood in one place, and a bed of coarſe gravel in another. When the bed of the river is gravel, it muſt be deepened by dredging; but the common method of dredging in uſe for deepening harbours, and the like, ſeems to me to be too tedious for deepening the bed of a river, where the operation is to be performed upon a great length of ſurface; and, therefore, we muſt contrive a method of raking or drawing the gravel to one or both ſides of the bed of the river. For this purpoſe, it will be neceſſary to have ſuch a flat-bottomed float as before deſcribed; and indeed it is chiefly for this purpoſe that ſuch a float becomes abſolutely neceſſary.

In ſome ſituations, it may happen, that a veſſel of a different and better conſtruction may be neceſſary for weighing up the drift-wood out of the mud, inſtead of dragging it horizontally; and where weighing it up will anſwer beſt, the float in that caſe ſhould be more in the form of a ſhip; and, therefore, I will ſuppoſe, that a ſhip ſhould be in readineſs, and ſhould be employed where circumſtances require it, as ſuch a veſſel will be much more managable in the water in all ſorts of weather, and will be eaſier moved up and down, and acroſs the river, than a clumſy ſquare log of a float, which would always be ſlow and difficult to move in the water.

If at any time a tree ſhould prove refractory to the force of the winch, ſuch a properly built veſſel might be faſtened to the tree at low water, when the tide is quite out, which would be moved and lifted up at the return of the tide before high water; and when it is weighed up out of the mud or ſand, ſuch a veſſel can be moved with the tree expeditiouſly to a proper place for depoſiting the drift-wood.

This ſhip, or properly built veſſel, will be of further uſe in drawing a large ſpiked roller up and down the channel with a wind ſail. Let this roller be made large and heavy, with ſtrong iron ſpikes placed pretty thick in it. When this is drawn up and down the channel as it turns round, the iron ſpikes will tear up, and looſen both ſand and gravel, and the weight of heavy currents will ſweep it away.

But with reſpect to ſuch places in rivers, where the bottom or bed is gravel or ſhingle, the flat bottomed ſquare float is neceſſary, becauſe ſuch ſhingle and gravel muſt be dredged or drawn to one ſide of the river, and ſometimes to both ſides, when circumſtances make it convenient.

The ſquare float for this purpoſe muſt be large or ſmall, or of a middle ſize, in proportion to the breadth of the river, and of the ſort of gravel to be dredged. If the river is very broad, the float muſt be large, becauſe the weight of the apparatus is conſiderably augmented when ſtretched out to a great diſtance; and where many great ſtones are lodged among the gravel in the bed of the river, it will require the more ſtrength to draw them out.

We ſhould now conſider what ſort of apparatus will anſwer beſt for ſcouring and deepening the ſtony and gravelly beds of rivers. It will require ſome ſort of grapnels to faſten upon, and draw out great ſtones. If the ſtones are very large and heavy, perhaps, that ſome inſtrument near the form of a ſhip's anchor, with a double or treble fluke, and more crooked than a common fluke, may anſwer the purpoſe.

What I mean by a double or treble fluke, is to have two or three flukes parallel to one another upon the ſame ſide of the ſhank, and ſo contrived, that they may all grapple, and keep a firm hold or gripe of the ſtone, until it is drawn aſhore by the crab or capſtane. In deepening great rivers, where there are many ſtones of various ſizes, it may be neceſſary to have two or three ſorts and ſizes of theſe ſtone grapnels. Large ſtones, beſides their own weight, will frequently be imbedded in ſand or gravel; and, therefore, every part of the apparatus muſt be powerful to draw them out of this bed. For ſcouring the gravelly beds of rivers, I would propoſe a ſort of large rake, with ſtrong iron teeth. For this purpoſe, get ſome ſtrong curved pieces of oak, elm, or other ſtrong timber, to make what may be called the heads of the rakes. The head of a ſtone rake, or a gravel rake, may be from four to ſix or eight feet long, as circumſtances admit and require.

The ſhingle in the channels of ſome rivers is exceeding hard, occaſioned by the weight and force of the ſtream, and of the admixture of ſmall gravel, ſand and ſlime, in which the large bowlders or bullets are faſt imbedded. For deepening ſuch channels as theſe, the head and teeth of the rake muſt be ſhort and very ſtrong. Where the gravel is more looſe, diſunited, and moveable, the head and the teeth of the rake or dredge may be conſiderably longer. Theſe heads muſt be from eight to fourteen inches diameter, in proportion to what they have to do. The head ſhould be ſtrongeſt in the middle, and a very little tapering towards both ends, in order to admit of a number of ſtrong iron hoops being driven very tight upon it, to keep it from burſting or ſplitting when at work. The ſhank of this inſtrument may be like the ſhank of an anchor, with a ring or loop at the far end, to faſten the capſtane rope to; but there is no occaſion for a ſtock, or that tranſverſe piece of timber at the far end, which is neceſſary upon the ſhank of a ſhip's anchor, to conduct the fluke to ſtand perpendicular to the horizon. The length of the head of this inſtrument is ſufficient to keep it right in the water. I obſerved before, that the head ſhould be a little curved, and the iron ſhank muſt be inſerted into the concave ſide of the head.

The end of the iron ſhank ſhould be made thin and flat, that is, of a broad ſquare, not above an inch, an inch and a half, or two inches thick, according to the ſize of the inſtrument, but it muſt be broad, in proportion to the thickneſs of the ſhank, ſo as the whole may be equally ſtrong. The mortice in the head ſhould be made to receive this flat iron tenon by driving it in tight, but without burſting. A waſher or flat iron ring muſt be put upon the end of the tenon, which reaches through the head; and above the ring, a ſtrong locker or cottrel muſt be driven into a hole, made for the purpoſe, in the end of the flat iron tenon, to prevent it from drawing out when at work. The ſhank muſt have two ſtays to branch out from the middle of it, one upon each ſide; and the extreme ends of both the ſtays muſt be faſtened to both ends of the head, which will keep it ſteady from yielding any way when at work.

The teeth and grappling-irons of this inſtrument muſt be long or ſhort, ſtrong or weak, in proportion to what they have to perform. Where the gravel is coarſe and hard, and as it were cemented together with ſand and ſlime, the teeth muſt be ſhort and very ſtrong; and where the gravel is looſer, and without a great mixture of large bullets, the teeth may be proportionably longer, and more in number. They may be from eight up to eighteen inches long, or more, without the wood, in proportion to their ſtrength, and the roundneſs and condition of the gravel they are to dredge. The teeth ſhould be made in the ſtrongeſt form poſſible, and a little curved, or bending forward towards the point.

The end of each tooth or iron ſpike, which goes into the wooden head or frame, muſt be ſquare, and each of them muſt be drawn up tight and firm above, either with lockers or ſcrew-nuts, with waſhers or rings under the nuts. The ſcrew-nuts is the beſt method. The mortices which are to receive theſe iron teeth ſhould be ſo pierced as to incline the teeth to lean forward a very little, like the teeth of a garden rake, which will make them ſtronger, and more apt to keep what they have before them. This is no more than the deſcription of a prodigious rake, with a very large and ſtrong wooden head, hooped with iron, a ſtrong iron ſhaft or ſhank, and iron teeth proportionably ſtrong. It now remains to be conſidered, how this inſtrument is to be uſed moſt effectually and moſt expeditiouſly in deepening rivers; and I think this the moſt difficult point to be determined of any I have yet touched. When it is out at the extreme diſtance from the veſſel, where it is to begin to work, there is no difficulty in bringing it home to the ſide of the veſſel; as for this purpoſe, in ordinary caſes, it only requires the ſtrength of men to go round with the capſtane bars, and one or two men below deck to coil the rope properly as it comes in; but the greateſt difficulty is, how to take it out again expeditiouſly to the place required, in order to fetch another ſtroke, and ſo on. I have examined ſeveral methods for that purpoſe, but I will only point out the one which appears to be the moſt effectual and expeditious, which is to carry it out every time with a boat made for the purpoſe. This boat muſt be built ſhort, broad, and ſtrong, able to carry a quantity of ballaſt greatly above the weight of the inſtrument. A pulley or ſhave muſt be made faſt to ſomething upon the further ſide of the river, oppoſite to the place where the float is moored. If the river is narrow, it may be fixed to a pole or poſt, driven or ſunk into the ground, or to an anchor; but if the river is very broad, it may be neceſſary to fix it to a boat floating at anchor. A ſmall rope, long enough to reach twice over the river, from the fixed block or pulley to the main float, muſt be drawn through the ſhave or pulley upon the far ſide of the river, and the one end of it made faſt to the head of the carrying-boat, and the other end brought about the ſpindle or axle of the capſtane above deck, but the contrary way from the big rope, which is to be managed below deck.

A pretty ſtrong but ſhort rope muſt be fixed about the middle of the head of the drag, or about the ſhank cloſe to the head, and the other end of it to the ſtern of the carrying-boat. Perhaps, it may be neceſſary to have a ſmall windlaſs upon the ſtern of the carrying-boat, to enable one or two men to lift up the drag or rake ſo far off the ground, that it will ſwim clear of the bottom.

When theſe ſeveral ropes are thus fixed, then the capſtane muſt go round backward, or the contrary way from drawing home the drag, which at once draws the carrying-boat away from the float over the river, and lets off the big rope.

It will be underſtood, that the ſmall rope which reaches twice over the river, has two or three turns round the capſtane ſpindle, but the contrary way from the big rope; ſo that, by this motion of the capſtane to let off the big rope, it draws out the carrying-boat over the river, without any aſſiſtance from the men in the carrying-boat. When the carrying-boat, with the inſtrument or rake hanging at the ſtern of it, is as far out from the float as ſhall be judged neceſſary, then the men in the boat muſt ſlacken the rope to let the drag fall to the ground, and then let the capſtane go round the right way, which at once draws home the drag with the big rope, and the carrying boat with the ſmall rope. In ſettling theſe matters, and fixing theſe ropes, it muſt be ſo contrived, that the big and little ropes are wound off and on equally faſt, otherwiſe there may happen ſome jarring and hindrance in the operation, which, if properly adjuſted, will go on regularly.

There muſt be a ſmall anchor dropt a good way up the middle of the ſtream, with a line from it to the carrying-boat, which will enable the men in the boat to regulate it, ſo as to drop the drag where they pleaſe, either further up or down the ſtream. When matters are thus adjuſted, there is little more to be done in ordinary caſes than to work the capſtane backward and forward, to lift the drag off the ground when it has brought home its quantum of gravel, let it down again in the proper place, and then to remove the big float and the oppoſite fixture with the pulley up or down the river, as occaſion requires.

When the gravel is looſe and fine, or ſmall, the teeth of the drag muſt be thick ſet, or numerous, and near one another; and experience will ſhew if it ſhould be neceſſary, in ſuch a caſe, to have a board or box, or ſome ſort of device, upon the head of the rake or drag, to receive, contain, and bring home a greater quantity of the looſe gravel at each draught. There are men of genius and acuteneſs in all countries, who know how to make the beſt uſe of all occurrences, ſo as to improve a general plan.

So far as the tide flows, the float, &c. can be moved up and down at pleaſure; but far up a country where the tide never flows, it may be difficult to make a proper uſe of the float, unleſs the river is very broad, as well as very deep; and therefore, in order to deepen a narrow river, and one of middling width, far up the country, either for improving the navigation of the river, or for draining land, or both, it will frequently be neceſſary to have a crab or winch erected upon land; and it will be very eaſy to have one upon land with equal, and even ſuperior powers to that on board the float.

When a winch or crab is erected upon land, the ſeveral members of it ſhould be fixed together with ſcrew-bolts, ſo that it may be eaſily taken aſunder and put together again; and where the ground is level, it ſhould be capable of being moved up and down the river ſide upon round pieces of timber or looſe rollers.

By theſe methods already pointed out, the gravelly and the ſlimy beds of rivers may be deepened at pleaſure. When drift-wood and ſuch rubbiſh is removed, the ſtream, when collected and united in force, will waſh away the ſlime, and carry it forward into the tide; and when the boulders, bullets, and rounder gravel is drawn aſhore, the ſmaller ſand will be carried forward by the force of the ſtream; however, it may be neceſſary, ſometimes to have drags, with teeth pretty cloſe to one another, in order in ſome caſes to draw very ſmall gravel aſhore, eſpecially where there is not a ſtrong current or ſtream; and it will frequently be neceſſary to remove the gravel drawn aſhore by dredging, off the banks of the river, to prevent the ſurges, the tides, or the land floods from waſhing it into the channel again. Spiked rollers may be of uſe for ſmall gravel as well as for ſand and ſlime, where there is a good current of water.

III. The rocky beds and channels of great rivers are moſt difficult of all to be deepened, and in ſome particular places, it may be quite impracticable, when a large river runs a great way upon a pavement of very hard rock which is concealed under water. However, all the rocky beds of rivers are not ſo deſperate.

It is common in all parts of the world for large rivers to be obſtructed in their courſe, and raiſed too high, by a bar or narrow ridge of rock, running quite acroſs, from the one ſide of the river to the other, which generally makes a waterfall over the bar. Theſe obſtructions ſometimes form the rivers above the bars into great lakes; in other places, into large moraſſes, which are lakes nearly filled up by the ſediment of the rivers; and in ſome places, the lakes and marſhes are ſo well filled up, as to produce meadows and firm paſture land upon both ſides of the rivers, which is the very beſt condition of the valleys and plains above the rocky bars; yet theſe meadows are overflowed by every inundation from the mountains, and they remain under water during the rainy ſeaſons, which, in ſome countries, continue near one half of the year. In theſe, and like circumſtances, it is proper to examine if it is practicable to cut down the rock, to give the river a lower and a freer paſſage. If the bar of rock can be cut down, and ſunk from ten to thirty feet lower, as may be requiſite, and the paſſage of the river made wide enough over the ridge of rock, I ſuppoſe that generally the point will be gained.

Let us now conſider how this difficult piece of work is to be performed. It is impoſſible to imagine all circumſtances relating to places and things which a perſon has never ſeen, which makes it difficult even for a man of ſcience, to point out the beſt poſſible method of executing ſuch a piece of work. However, it generally, if not always happens, that in the dry ſeaſon, when the river is low, ſome part of the rock will be out of water, upon one ſide or other of the river. Upon this dry rock, the workmen ſhould begin as far down below the bar and water-fall as poſſible, and cut a deep and wide trench in the rock, parallel to the ſtream of the river, quite up through the bar, and as far above as may be judged neceſſary.

A banking of turf ſhould be made between the cut and the river, to keep the water off the workmen, in caſe of the river ſwelling a little after a ſhower of rain, and the trench in the rock ſhould be made deep and wide enough to contain all the water of the river in dry weather. When this parallel trench is carried far enough up the ſide of the river, all the water muſt be turned into it, and a wear or dam muſt be made in a diagonal direction acroſs the river, below the head of the trench or new channel, to prevent any of the water from running in the old courſe over the ridge of rock, and then the labourers may begin low enough, and work down the bar of rock to the depth propoſed, leaving a thin partition of rock between themſelves and the artificial trench, to keep off the water while they are at work.

If this work is well executed, and the bar of rock ſunk low and wide enough, it muſt have the effect of draining the plains above, and of preventing their being overflowed in the rainy ſeaſons, which will render them fit for any manner of culture; and it will produce the additional happy effect of a more pure and ſalubrious air all over thoſe plains.

When ſuch bars of rock are improving, care ſhould be taken to work down the principal channel loweſt in the middle or near one ſide, ſo as to improve the navigation of the river over the rock.

The greateſt difficulty in the way of repairing the rocky beds of rivers for improving river navigation, is how to get the better of ſunken rocks, which are always under water, and yet are ſo ſhallow, that veſſels cannot paſs without ſtriking upon them, which is very dangerous.

I have conſidered all the beſt methods of working down rocks under water; but as a full deſcription of the methods, and of the ſeveral inſtruments, would be tedious, and as it is very difficult to work away rocks under water to a ſufficient depth for the purpoſe of navigation, I

think

think it much better to adviſe attempting either to turn the river off the ſunken rock while they are working it down, or to make a new channel for the river fit for navigation in ſuch places, in order to ſhun theſe ſunk rocks.

Where the inland navigation of a large river is very bad, with rocks or other obſtructions for a conſiderable length, and that the improvement of the old, or the making of a new channel is impracticable, then they ſhould make a ſufficient navigable canal with locks, to paſs by ſuch a difficult part of a river; the canal to communicate with the river below and above the difficult part.

There is a ſimple and frugal method of deepening and improving ſmall and middling rivers, for the purpoſes of preventing the inundations of the flats,—of preventing them from changing their courſe,—from endangering towns or fields,—or for any other purpoſe. Any alterations, uſes, or changes, may be made of the moſt of rivers, by very ſimple methods, and the moſt ſimple are generally the beſt.

The courſe of all the rivers of the world depends upon the figure and declivity of the ſurface of the earth, in the countries through which they run from their ſources to the ſea. A level plain, or a flat valley of very little declivity, is liable to be ſanded and otherwiſe injured by the inundations of the river which runs through it, whether that river is great or ſmall. Gravel, ſand, and all the rubbiſh which the currents bring down from the mountains, is ſure to be lodged in great quantities in ſuch plains and valleys; and this rubbiſh fills up the natural channels of the rivers in ſuch level ſituations; but when the natural channels, or beds of the rivers, are filled up and obſtructed, they will overflow their banks, and cut new ground after every heavy ſhower of rain. In this caſe, ſeveral parts of the old channel will be choaked up; but when the flood has run a little way in the newly cut channel, it will return again into the old one further down; and this is the origin of the very irregular and winding courſe of ſome rivers. When the bed of a river is thus raiſed, and its channel obſtructed, whether near the tide, or further up the country, it is ſure to overflow its banks in every land flood, and each of theſe inundations is ſure to lodge more matter in the plain or valley, which gradually increaſes the irregularity and diſorder in the courſe of the river; and thus a great deal of miſchief is done every year, by the greateſt number of all the rivers in the world.

Fire and water are neceſſary, excellent, and powerful ſervants, when properly employed, and directed by the wiſdom and induſtry of man; but they are always dreadful, and frequently very deſtructive maſters. The wiſe and induſtrious

Chineſe have made the beſt uſe of all the water of their empire, and their whole empire is a well watered garden.

All other countries of the torrid and temperate zones of the earth might likewiſe improve their rivers, and they might make immenſe improvements of their lands, and of their commerce, by means of the rivers, if they had but a part of the wiſdom and induſtry of the Chineſe. But almoſt all the other princes of the world think it more glorious to lead out their people to be deſtroyed in the ſanguine field of battle, than to lead them out to plow, and to other improvements of their country, like the Chineſe emperors.

Above I have pointed out ſome of the methods of improving the channels of great rivers. I will add one obſervation to what I have ſaid above before I proceed to the ſmall rivers, viz. where the bed of a large river is greatly filled up, ſo as to be raiſed on a level with, or above the collateral plains and marſhes, and that the channel of it is greatly obſtructed by the roots, trunks, and branches of drift-wood carried down by the floods, and lodged perhaps to a great depth in many parts of the true channel of the river, which may be the cauſe of its dividing into ſeveral branches before it reaches the ſea, and its entering the tide by many mouths; in this caſe, it may be proper to examine the level ground and the moraſſes upon both ſides of a large river, to ſee if a new channel can be cut and made for it upon one ſide or the other of its preſent courſe, in a ſtraight line, from the tide all the way up to the place where it begins to break off, and to ſeparate into ſeveral branches, and, in this place, to bring the whole collected ſtream of the river to run in the new channel. Where this may be done with propriety, care muſt be taken to make the new channel deep enough near the junction with the old. When the river is turned into the new artificial channel, care muſt be taken to defend the old paſſage of the water with ſtrong bulwarks, in which a great many piles made of whole trees muſt be driven, to prevent any part of the river from ever paſſing that way again; and theſe trees ſhould be aquatics. However, in general, where too much drift-wood, or ſome ſuch obſtruction, does not make it impracticable, the method pointed out above of removing obſtructions, and confining the river between lines or parallel bulwarks, in a ſtraight courſe through the plains from the high grounds to the ſea, will, I apprehend, be the moſt eligible plan of operation; and afterwards to deepen this artificial channel between the lines by degrees. But I will here beg leave to enter a caveat againſt this or any other method of banking without deepening, excepting againſt the tide only, becauſe it will be labour loſt where the tide is not concerned. The beds of all or moſt of the great rivers of the world, are raiſed too high with the matter lodged by their own ſtreams, moſt of them above the level of the collateral plains and moraſſes, which is the general cauſe of their dividing into ſeveral branches before they reach the ſea; and, therefore, any attempts to confine ſuch rivers in channels which are elevated above the collateral plain countries, would prove ineffectual and uſeleſs, however great the expence and labour might be.

We ſhould have three great objects in view when we undertake the deepening of great rivers, viz. 1. The acquiſition and improvement of a great extent of rich land upon the rivers near the ſea; 2. The improvement of navigation, which always increaſes the value of the land; and 3. The acquiſition of a pure and ſalubrious atmoſphere, where putrid unwholeſome vapours formerly aroſe from the ſtagnant moraſſes, and poiſoned the air; and this third bleſſing enhances the value of the other two improvements; and without it, the moſt flouriſhing ſtate of ſociety and commerce can give no true and laſting felicity. But neither of theſe great and valuable acquiſitions can be obtained by an elevated channel of the river.— The collateral plains and moraſſy grounds cannot be drained into a river, whoſe bed is on a level with, or perhaps higher than ſome parts of thoſe moraſſes; and, of courſe, the putrid ſtagnated moraſſes, and the peſtilential air, muſt remain as they were, nor can the navigation be good in ſuch a river, becauſe it is liable to many obſtructions, and to change its dry weather channel.

A regular deep channel cannot be preſerved without ſinking the bed of the rivers.

It is ſaid, that the American river Oroonoko overflows its banks near ſix months in the year, during which time, ſome fertile iſlands, and immenſe tracks of the richeſt ſoil in the world, upon the banks of this great river, lies ſteeping and ſouring under water. But when the inceſſant rains and melted ſnow which feed theſe inundations begin to fail, and the river falls within its banks, the vapour which the ſun exhales from the raw and humid ſurface, from whence the water has newly retreated, corrupts the air, and makes one of the richeſt countries in the world a ſcene of miſery, ſickneſs, and death. What a bleſſing would it be to the miſerable inhabitants of the banks of that river, and the many other great rivers of the world which overflow their banks, and enter the ſea by many mouths, if they were improved, and led to the ſea in one united ſtream, and their channels deepened, ſo as to prevent the inundations, to facilitate the draining and meliorating their fertile banks, and the adjacent plains and moraſſes, and to improve the inland navigation, and purify the air! Theſe are invaluable bleſſings, which a ſufficiently deep and wide channel, and a ſtraight unobſtructed courſe of the rivers, would facilitate the acquiſition of. It is a confined, ſhallow, obſtructed courſe, that is the firſt cauſe of ſtagnation. A deep and regular channel will pour out more water into the ſea in one hour, than a ſhallow, irregular, and obſtructed channel will in ſix. We have a familiar demonſtration of the truth of this frequently before our eyes. How many ſmall rivers and large rivulets have we ſeen, which made a lake of a valley after every great ſhower of rain, while they were allowed to creep and warble through their old irregular, obſtructed, meandering channels, which run clear off in the greateſt floods, when new channels were cut for them in a ſtraight line up the valley, and ſome of them will not half fill their new and regular channels.

This is a perfect demonſtration of the truth of my doctrine reſpecting the improvement of the channels of great rivers which are ſubject to inundations. We have only to make the channels regular, deep, and wide, in proportion to the magnitude of the river, when in flood; and the water will run off in a ratio, or true proportion, of the different quantities of water in the great and little rivers,—of the depth and wideneſs of their ſeveral channels, and of the velocity of the current of each; and a ſtraight and uniformly regular channel always facilitates and increaſes the velocity of the current. If the ſeveral mouths of the Danube, and many other European rivers, were collected into one ſtream, and their channels made ſufficiently deep, wide, and regular, for facilitating inland navigation, what immenſe advantage would it be to the commerce and agriculture of the countries thro' which they run to the ſea.

The inland navigation of many European rivers might be greatly improved at ſmall expence, by deepening their channels, as directed above; which would be an immenſe and a laſting benefit to the manufactures, commerce, and agriculture of the countries upon both ſides of ſuch rivers.

With reſpect to the ſmall rivers of Britain, and other places which are ſubject to inundations, or to deviate from their proper courſe, and injure towns, roads, fields, or ſingle buildings, the moſt ſimple and frugal method of deepening and improving the channels of ſuch of them as run upon a bed of ſtones, is, to get a number of men, women, and children, in ſummer, when the river is low, and pick up all the ſtones out of the proper bed or channel of the river, from the bigneſs of the fiſt and upwards, to the largeſt of all, and lay them down upon one or both ſides, as the ſituation and figure of the ground admit; always taking care to lay them ſo far out of the current, as to give room enough for the river in flood, and to be out of danger of the floods ſweeping them in again. When all the ſtones which are preſently ſeen are carried out, let the work ſtand until more are diſcovered. The firſt heavy ſhower of rain will waſh away the ſand and gravel, and diſcover more ſtones, which may be alſo carried out as ſoon as the river is low enough, and a ſecond flood will ſtill diſcover more deeper down; and if all the great and ſmall ſtones which are laid bare by every flood, are carried out of the proper channel, a river, by this ſimple method, may be deepened as low down as you pleaſe, without any material expence. This method of deepening or ſinking the beds of ſtony rivers is as effectual as it is ſimple; and I am confident, that it will not coſt five per cent. of the expence of any other method that can be deviſed. That it is effectual, I know by experience; and a few people will clear a great extent of channel in a day, unleſs many of the ſtones are ſo large as to require levers, and much labour to remove them. When the river is too big for men to ſtand and work in the ſtream in ſummer, then the channel muſt be cleared with ſtone and gravel rakes, as directed above. A very little work well timed, upon this principle and method, will frequently prevent the miſchief and havock which many rivers make by overflowing and changing their courſe. By lifting the ſtones chiefly out of the ſide, or courſe where you want the river to run, you may by degrees humour the current, and lead it any way you pleaſe.

Where the beds of rivers are chiefly ſand or gravel, their channels muſt be deepened and improved, by dredging with rakes of different ſizes, as directed above, and by rolling with ſpiked rollers, which will lift up the ſand, and mix it with the water, and the ſtream will carry it away by degrees.

I am fully ſenſible, that all the methods of deepening and improving the channels of great rivers, which I have pointed out, are arduous, expenſive, and difficult. The work, in many inſtances, is of ſuch vaſt magnitude, that it may appear to many quite impracticable; however, genius, induſtry, and a true ſpirit for improvement, ſeldom look upon difficulties in this light, and eſpecially when ſtimulated by the neceſſity of the improvement, and the glory and advantages to be gained by it. What has man failed to accompliſh, when the end and the means were equal to the undertaking? When the great Creator beſtows genius and a comprehenſive mind upon any of the children of men, he alſo with it communicates the image of his own omnipotence, which qualifies the man of genius to plan and execute great works, both for utility, and for ſplendour and oſtentation. Look abroad into the world, and conſider a little what great things have been done; and are our powers more confined and weakened now, by the very great improvements in philoſophy and ſcience? No. Philoſophy now applies the principles of mechanics to the uſeful arts, and valuable diſcoveries and improvements are daily made, and making, which are of inconceivable benefit to ſociety.

If the nations and rulers of the world would combine their forces, and make good uſe of the means which Providence hath put in their power, nothing would be too hard for them. Would they but employ, for one age, the one half of the men and money which is deſtroyed by them, in every age, upon uſeleſs, cruel, and capricious wars, the great works which I point out might be conſiderably advanced in that age; and what is the object? The means to be employed in any undertaking is always to be juſtified by the object or end to be gained thereby; and here the object and end is truly laudable and great; no leſs than the acquiſition of another world to be added to the preſent, without enlarging the bounds of the terraqueous globe, and that world, ſo united, many times more ſalubrious, fertile, and convenient for the mutual commerce, wealth and happineſs of ſociety than the preſent, in all parts of the earth! The uniting the ſeveral quarters and families of each continent together into one compact convenient neighbourhood, by improving the navigation of the rivers and the waſte lands, and by correcting and improving the climates of the world, and driving out ſickneſs, and weakening the power of immature death.

A war upon want, ſickneſs, and death, is worthy of a new ſet of knights errant; and in theſe papers I point out a large field for adventure, and all their exploits are ſure to be recorded in the rolls of Heaven.

What exploits can be more worthy of a place in the celeſtial chronicles, than procuring plenty, health and convenience to millions of the children of men! Your Alexanders and Cæſars are famous in the records of men, for having deſtroyed millions of the human race; but what good has either of them done? But the wars I point out are againſt the worſt enemies of the human race, ſickneſs, famine, and premature death; and the conquerors in this field would be immortalized, as the fathers and laſting benefactors of mankind to endleſs ages; and they are certain of ſecuring endleſs praiſe from God and all good Spirits, for having done good in this world; and as a ſecondary motive to ſuch worth and greatneſs, there is ſo much gratitude among men, that the memory of ſuch illuſtrious actions, ſuch unbounded benevolence, would be handed down to lateſt poſterity.

Theſe great works of deepening rivers and draining marſhes, for increaſing and improving the ſoil, and correcting climates, would be convenient in many parts of Europe, and peculiarly neceſſary in Aſia, Africa, and America.

If the Danube and other great rivers of Europe were properly deepened, and otherwiſe improved, it would greatly improve inland navigation, as well as the ſoil and climate; and then we ſhould not hear ſo frequently of towns and villages, and people, and ſtock, being ſwept away, and of ſuch other loſſes and devaſtation from almoſt every land flood that happens; and, moreover, ſuch deepening would greatly increaſe the wealth and proſperity of Europe; and by the ſalubrity and equanimity of climate which the improvements hinted at would procure, diſeaſe and famine would not be experienced as now. The malignant and ſickly climates of ſome parts of Aſia, and of almoſt all Africa, and the extreme cold in winter, and malignant climates of America, are almoſt entirely occaſioned by the watery, humid, and undrained ſtate of that country. The greateſt part of the ſurface of the continent of America is covered with lakes and woods, the ſtagnations of rivers overflowing their banks, and of conſequent moraſſes. Upon ſuch a face of the country, the rays of the ſun are plunged and abſorbed in a watery ſurface, or in the damp ſhades of the woods, and the atmoſphere is always overloaded with humid and putrid vapours. To ſay with Raynal and others, that the woody, humid, and cold ſtate of America are marks of infancy, or of its having lately emerged from the waters of a deluge, is nonſenſe. Without the effectual application of the improving hand of man, theſe marks of imperfection will continue and increaſe to eternity. The great rivers of America have formed prodigious tracks of new land upon the ſhores, and in the plains; the beds and channels of theſe rivers are every where choaked up and riſen, and continually riſing much higher, by which extenſive lakes and moraſſes are formed, and ſtill increaſing; and without the improving hand of man, they will ſtill increaſe, and grow worſe and worſe, while the world endures. The woods of America now cover immenſe tracks of the beſt and naturally drieſt lands, which continually increaſe in humidity, by the ſtagnations of decayed vegetables; and this evil will never decreaſe by the ordinary courſe of nature; and it is well known, that all the rays of the ſun are abſorbed in the damp and putrid umbrage of immenſe woods, from whence a tainted ſickly vapour muſt exhale for ever, as well as from the ſtagnant and putrid moraſſes, both of which emit living ſteams, loaded with various *animalculæ*, which are ſickneſs and death to the human race, and to moſt of the uſeful domeſtic animals; and, therefore, unleſs the rivers of America are deepened, the moraſſes drained, and the prodigious foreſts cut down, or greatly thinned and perflated, the climates will for ever continue as they are, or grow worſe.

It is well directed induſtry that meliorates the various ſoils and climates of the nations, and makes them fertile, pleaſant and ſalubrious. There is an infallible proof of the truth of what I aſſert, in America itſelf, to be adduced from experience, without recurring to the principles of philoſophy, and in the experience of all other countries over which the hand of induſtry has paſſed. The climate is already very much altered for the better in the provinces of North America, where a very ſmall part only of the woods have been cut down, and of the lands improved; but very much remains to be done there yet, towards the effectual improvement of the navigation of the rivers, the fertility of the ſoil, and the ſalubrity of the climate and atmoſphere. Deepening the great rivers of America, as low as the tides will allow, in the maritime plains, and as low as circumſtances will require in the inland countries, would at once improve the navigation of thoſe rivers, facilitate the draining of the moraſſes, and prevent in future the inundation of the plains in rainy ſeaſons. Collateral cuts from the deepened rivers, properly directed through the loweſt parts of the moraſſes, and theſe interſected by ſufficiently large ditches, will effectually drain the ſtagnations in the plains upon both ſides of the rivers. The main drains or collateral cuts from the deepened rivers, may be laid out and made in ſuch a manner as to anſwer for navigable canals, which may come to be of inconceivable utility in other extenſive countries, as they now are in China.

Where the moraſſes are deep and boggy, allowance muſt be made in the depth of the principal canals and interſecting ditches for the ſubſiing of the chaotic ſurface, when the humidity is drained out of it. But this is too particular for my plan, which is only to touch at ſome of the principal parts of my ſubject in brief and curſory hints.

Deepening the beds of the great rivers of America, and ditching the moraſſes, will drain an immenſe quantity of water off the ſurface of that continent. When the beds of the rivers are ſo deepened as to prevent inundations in rainy ſeaſons, ſuch plains upon the banks of the rivers, as now only afford indifferent paſture in the dry months of the year, may then be improved for proper crops. Proper canals and interſecting ditches ſhould alſo be made in the ſavannahs of America, to carry off the water as it falls upon them in the rainy ſeaſons. Stagnating waters ſour the ſurface of the ground, and taint the air with putrid exhalations; and, therefore, the ſooner the rain water runs off theſe extenſive graſſy plains, the ſweeter the graſs and the purer the atmoſphere will prove.

The proper management of the woods of America would alſo have a mighty effect towards improving the climates and atmoſphere of that great and now unhealthy continent. If the ſurface of America was improved like the ſurface of China or England, the climate or atmoſphere would become as temperate and ſalubrious. The condition of the ſurface of the ground, and the ſtate of agriculture in a country, makes and determines the climate and quality of the atmoſphere more than its ſituation in point of latitude. This is a fact remarkably well experienced in all well cultivated countries, and in the near neighbourhood of all dry mountains and ſandy or gravelly plains. To purify the atmoſphere from the damp and putrid exhalations of the prodigious foreſts of America, wide avenues ſhould be cut through them in the direction of the prevailing winds, and great care ſhould be taken to drain them from all humid ſtagnations. There are certain points of the compaſs from which the winds blow the greateſt part of the year in all countries.—The avenues through the woods ſhould be cut in the line of theſe prevailing winds, that they may blow through freely, to perflate every part of the woods, and diſperſe and carry away the generating damps and putrefactions of the foreſts. The columns or ſtrips of wood to be left ſhould be as narrow and as thin as poſſible.

The real demands of the country for timber ſhould be the only rule by which to regulate the breadth of the ſtrips, and the diſtance of the trees from one another in each ſtrip; and the hedge row trees ſhould be taken into the account of the quantity of timber neceſſary. The land of the avenues between the ſtrips ſhould be well drained and improved, and every part of the ſtrips ſhould be perfectly well drained, becauſe one acre of humid ground or under wood will produce more putrid vapour to taint the air, than a thouſand of well cultivated land. Particular care ſhould be taken to be very exact in draining and perflating the woody parts of the countries between the tropics, which undoubtedly will have a mighty effect in purifying the air, and improving the climate of thoſe unhealthy regions. In warm countries between the tropics, no humid ſtagnations ſhould be left upon any part of the ſurface of the ground, as ſuch places are the fertile wombs and nurſeries of ſickneſs, and immature death to the miſerable inhabitants. The utmoſt care, ſkill, and exactneſs ſhould be employed in draining every foot of ground in theſe warm climates, and in perflating the woods, by cutting avenues through them. A much leſs quantity of wood ſhould be left in warm countries, than in thoſe that are cold, becauſe there is much leſs needed, eſpecially for feuel. If the lands were properly improved in theſe warm countries, the prunings of a ſmall quantity of wood would go far towards the neceſſary ſupply of feuel; but as the ſun is frequently hot in theſe countries, the ſhade of ſtrips of wood may be very neceſſary for man and beaſt; however, if they are neceſſary, they ſhould be very narrow, and, perhaps, they ſhould be formed in undulating lines, that the cattle may find ſhade in the concavities of the undulations, when the ſun is in a line with the ſtrip, which will happen every day.

It was obſerved before, that as little humidity as poſſible ſhould be left upon the ſurface of the ground in warm countries. In draining the ſavannahs, the arable and paſture lands, and the ſtrips of wood in ſuch countries, as many covered drains as poſſible ſhould be made, eſpecially in level ground, becauſe ſtagnant ditch water in ſuch places teems with myriads of reptiles, inſects, and *animalculæ*. The Kings of Spain and Portugal, with their ſubjects, are highly intereſted in the purport of theſe obſervations. Were the rivers deepened, the moraſſes and ſhallow ſtagnant waters drained, the woods perflated, and moſtly taken away, and the lands well drained and perfectly cultivated, the climate and atmoſphere of South America, and the Braſils, would become as healthy, pure, and ſalubrious as ſome parts of the continent of Europe. If the woods of *terra firma* were cut down, and the lands perfectly drained and improved, and no ſtagnations of any kind left to putrefy, Carthagena, Portobello, and other like places, would then become the ſcenes of firm health, beauty, joy, and vigorous activity, as well as of fertility and abundance of all things. This is the effectual method to drive away ſqualid ſickneſs, miſery, and want out of the world, even from every climate. In purſuing ſuch improvements, ſpecial regard ſhould be firſt paid to maritime places, which are conveniently ſituated for extenſive commerce, becauſe ſuch places are remarkably uſeful and neceſſary to further the improvement of the reſt of the world.

The purport of theſe obſervations is of ſuch magnitude and importance to the welfare of the world, and eſpecially of the new world, that they merit a ſerious enquiry whether they are founded in truth or not, and they will bear the ſtricteſt ſcrutiny. They are founded upon ſolid principles, and they have the experience of ages, and of all cultivated nations, on their ſide. The truth of them can be proved to the cleareſt demonſtration, and innumerable examples could be produced in proof and illuſtration; but ſuch a deſign is entirely out of my plan, which is to drop as many general uſeful hints as poſſible in a very few pages, and leave them to be examined and improved by the world; and I truſt that they will ſtand the teſt. Look over the face of the continent of America in its preſent ſtate: what does the ſun ſhine upon there? Upon woods, lakes, and marſhes—upon the wide inundations of great rivers, or upon the ſlime which they have depoſited—upon large plains and ſavannahs, which are choaked with the putrefying fruits of their own fertility; and what can the ſun exhale from ſuch a ſurface? Nothing but the fetid ſteams of ſtagnant water, and of putrid vegetables; and theſe loſe none of their malignant qualities by floating in the air, but carry ſickneſs and death upon the wings of the winds, or rather in every motion of the lungs of the wretched inhabitants of thoſe countries.

While the richeſt fragrance of flowers and fruits exhaled from the enamelled meadows, fruit trees, and well cultivated fields of the moſt of Europe, a conſiderable part of Aſia, and a ſmall proportion of Africa, perfumes the atmoſphere with pleaſure, health and joy; every gale in America, and moſt of Africa, is at the beſt overloaded with humidity, and generally tainted with the ſqualid ſteams of ſtagnant water and putrefied vegetables; and magnifying glaſſes ſhew us, that ſuch water, and ſuch rotten and rotting vegetables, are replete with various forms of life, ſo minute as eaſily to riſe and float in the air, imperceptible to the naked eye of man; but this living atmoſphere is ſickneſs, pain, and death to the human race, and to many other animals.

O ye rulers of the world, ye men of wiſdom and power! weigh theſe conſiderations, which are ſeriouſly and honeſtly, though rudely, laid before you, for your information and emolument! The beds of the rivers may be deepened and improved,—the moraſſes and ſhallow lakes may be drained,—the unneceſſary and noxious foreſts may be cleared away off the face of the earth. The ſour ſavannahs may be ditched and ſweetened, and the idly fertile plain fields and meadows which emit deadly vapours, from the putrid redundance of their now uſeleſs productions, may be perfectly drained and well cultivated. And what would be the conſequence of all theſe great works, ſuppoſing them to be performed? It would (as I ſaid before) add another world to the preſent, without enlarging the bounds of the earth, and that world would be capable of maintaining nearly as many men and beaſts as the preſent; and, therefore, it would double the ſtock of both, with the means of employing and maintaining them. It would connect the various parts and families of each continent together, into one great and populous neighbourhood, and procure them health and plenty, with all the conveniencies and all the advantages of mutual intercourſe. By removing the ſtagnant, crude, and putrid cauſes of the corruption of the air, it would be the effectual means of procuring and diffuſing a more ſimple, pure, and ſalubrious atmoſphere over all parts of the globe; ſo that all men every where may draw in health, joy, and long life with every breath, and perhaps they might by degrees, in the courſe of time, recover the ſtrength and longevity of the Patriarchal ages. And are there any other ſuch objects of purſuit and acquiſition in this world? None that I can comprehend. What are all the mines of gold and jewels in the world to theſe acquiſitions? The means and accomodations of life, and of multiplied population and induſtry, and of mutual and extended commerce, is the real wealth and happineſs of the world; and all this of courſe reſults from the propoſed improvements.

I wiſh to ſay as little as poſſible upon every part of my ſubject, to make myſelf properly underſtood; but perhaps I have ſaid too little about the woods of America; and when I ſpeak of

America, I beg leave to obſerve, that the ſame improvements will be uſeful and ſalutary to Europe, Aſia, and Africa, under nearly the ſame parallels of latitude; and with reſpect to the rivers and moraſſes in all latitudes whatever. I adviſe clearing away the moſt of the wood of America off the face of the country. But I am aware that the inhabitants will plead the neceſſity of preſerving the woods for the important purpoſes of building and feuel; and I am ſenſible that they cannot ſubſiſt without both, and therefore, a ſufficient quantity of timber muſt, ſome how or other, be reſerved or procured for them.

In order, at once, to remove the noxious effects of the preſent woods, and to give a ſupply equal to their neceſſities, I propoſe, that the ſides and ſummits of dry mountains ſhould be covered with wood, and that the dry banks, or ſides of ravines and dales, be filled with wood; and, I imagine, that theſe ſituations, along with the hedge rows, where they are uſed, and ſome few very narrow ſtrips, would be ſufficient for all their neceſſities.

The ſides of dry mountains, and the dry ſides of dales and ravines, will certainly grow enough of timber for the tropical inhabitants, and for thoſe of all other warm countries; and therefore, they ſhould let no wood grow upon their plains, nor upon any of their humid or very fat grounds, excepting ſome ſingle trees, and a few rows or lines to afford a ſhade from the burning rays of the ſun: And, if all the woods were cleared off the plains and richer ſoils, and all the moraſſes and ſavannahs drained, and the face of the country well cultivated, the cold parts of America would then become much warmer, and of a more equal temperature in all ſeaſons of the year; and the climates and diſtricts which are at preſent noxious, ſickly, barren, and mortal, would become perfectly healthy, fertile, and agreeable.

The ſum of all the advantages which the nations of the world will reap by the great works and improvements propoſed to them, may be briefly comprehended in three general heads, or propoſitions, viz.

1ſt, The acquiſition and improvement of numerous parcels or tracts of land in almoſt all parts of the world, ſuppoſed to be nearly equal in value to all the land in the world at preſent under culture, conſidering the fertility and convenient ſituation of the lands to be gained for induſtry and commerce.

2d, The removing of all the ſtagnant waters, putrefactions, and other cauſes of noxious vapours, off the face of the earth, and creating a ſimple, pure, and ſalubrious atmoſphere over all parts of the globe, which would procure more temperance and equanimity of climate and weather every where, without too much rain, &c. in thoſe places which are now deluged and ſteeped in water for half the year, or more; and, in courſe of time, the health and longevity of the human race would be greatly increaſed.

3*d*, The improvement of the inland navigation of the world would greatly enhance the value of the firſt article, and would be a very great convenience to all parts of the earth. And here I may venture to make a plain and obvious remark, viz. that theſe three acquiſitions are ſo far connected, and depend ſo much upon one another, that each of them enhances the value of the other two, and neither of them would be of half its real value without the others.

Before I conclude theſe curſory hints upon this great ſubject, I beg leave to expreſs my regret that I cannot with equal confidence point out a certain and infallible method of improving the ſandy deſarts of Barca, Arabia, &c. which are a vaſt nuiſance upon the face of the earth; and, therefore, I could wiſh to ſay ſomething to the purpoſe upon ſuch an intereſting ſubject. But I find it exceeding difficult to treat this topick in a practicable and ſatisfactory manner.

It is unneceſſary to give any hiſtory of theſe deſarts. It is well known, that the ſandy plains which are found in ſo many parts of the world, are pernicious in three different ways:

1*ſt*, As they occupy ſuch extenſive tracts of the ſurface of the earth, which is now entirely uſeleſs, but which would be exceedingly valuable in ſuch ſituations, if only middling ſoil.

2*d*, Theſe ſands are always dry and parched. There is not ſufficient humidity in ſuch places to abſorb and qualify the burning rays of the ſun, and therefore, in the hot weather of dry ſeaſons, the natural heat of the ſun in ſuch places is ſo much increaſed, that the atmoſphere becomes too hot for the life and health of man or beaſt; and this exceſſive heat rarifies the air to ſuch a degree, as frequently to generate ſuch high winds and tempeſtuous weather, as ſweeps all before it.

3*d*, Theſe winds and tempeſts make the ſandy plains ſo exceeding troubleſome and dangerous for travellers, that many thouſands of lives are loſt in them. It is not uncommon for a whole caravan, conſiſting frequently of more than a thouſand men, beſides a ſtill greater number of cattle, to be buried at once under the ſand, which, in a ſtrong wind, overwhelms them in a moment; and it has ſometimes happened, that whole armies have been buried alive under tremendous billows, or moving mountains of ſand. I need not ſay more to make it appear a deſireable acquiſition for the welfare of the world, if ſuch a dreadful nuiſance could be removed out of it, or at leaſt be ſo far remedied, as to prevent its effect from being ſo very pernicious and deſtructive.

Let us now enquire if the thing is at all practicable; and here I can aſſert nothing with confidence. All I pretend to do, is, with diffidence, to ſuggeſt ſuch thoughts as occur to me, which appear to have ſome probability of ſucceſs. High mountains of ſand, or ſuch deſarts as are of very unequal ſuperficies, are quite out of the queſtion. It is only ſandy plains that we ſuppoſe any way practicable; and with reſpect to theſe, it is ſuppoſed, that moſt of the ſandy plains in the world are ſituated lower upon the plane of the horizon than the ſources of the neareſt rivers to each of them; and if ſo, it is further ſuppoſed, that ſome parts or branches of ſuch rivers can be turned out of their ordinary courſe or channel, and led or conducted on to the ſandy plains. Where the ſandy plain is extenſive, a ſmall river will not be ſufficient, and, therefore, it is neceſſary to look out for a large one, which, perhaps, is not to be found at a moderate diſtance. However, ſuppoſing it ſhould be more than a hundred miles off from any part of the deſart, it is, notwithſtanding, neceſſary to have it.

The expence of cutting a new channel for ſuch a river, to lead it to the neareſt part of the ſandy plain, will be very great; and we ſuppoſe, that the benefits and conveniencies to be gained by it, will alſo be very great. However, when the river is brought to the ſands, the work is only begun. It is neceſſary to ſpread it over the ſands in a lake of ſome feet in depth, and to keep it there for a conſiderable period of time, if not for ever, which will every where be an arduous taſk, and in ſome places quite impracticable.

This lake is to be made by banking quite round the ſandy plain. This bank, mound, or rampart muſt be of great length to encompaſs large ſandy plains; however, it will not in all places require to be of great height; and as turf and clay are the moſt proper materials, theſe will generally be found at a ſmall depth under the outſkirts of the ſands, and they are eaſily dug and put together; and in ſome places the ſkirts of hills and riſing grounds will anſwer as part of the ſurrounding artificial mound. It is ſuppoſed, that three or four feet deep of water, all over the ſandy plain, is ſufficient; for although hillocks of ſand ſhould riſe far above the ſurface of the water, the wind will ſoon blow them down into it, which, in the courſe of no long time, will produce a level, or a vaſt, though ſhallow lake.

I am aware, that the evaporation would be ſo very great from ſuch an immenſe ſurface of water, that few rivers in the dry ſeaſons would be ſufficient to ſupply the waſte; but the rivers of thoſe countries generally overflow their banks once a-year at leaſt; and care muſt be taken to make the new channel ſufficiently capacious to bring enough of water to the ſands in the wet ſeaſons; and the inundations of the rivers will bring down from the mountain ſuch a quantity of earth and ſlime, as will in the courſe of time form a coat of ſoil over part of the ſands, upon which vegetation will ſoon appear, even under water; and, when the water decreaſes in the dry ſeaſons, it will increaſe or thicken to a good ſurface or coat of graſs.

Where the line of circumference round the outſide of the ſands is not upon a perfect level, they ſhould only aim at laying a certain diſtrict or diviſion of the ſands under water at once, ſuppoſing it was no more, or even leſs, than a third part at one time; and it ſhould be conſidered, whether or not more than one river can be turned on to ſuch irregular, or on to any extenſive deſarts. When great rivers are turned out of their ordinary courſe for the purpoſe of flooding ſandy deſarts, I am ſenſible, that the navigation from the ſea, if there is any, will be rather injured than improved; however, if the new channel is formed with a view to that purpoſe, the inland navigation may be greatly improved, as, by reaſon of cataracts and water-falls, many rivers are incapable of inland navigation in their preſent ſtate. Where the figure of the ſurface of the ground makes it neceſſary to flood the ſands piece-meal, it is preſumed, that the diſtrict of ſand which is under water will, in a few years, be levelled by the winds, and the agitation of the water; and that the ſurface of the ſand will be ſo immixed with the mud or ſediment of the river, as to produce a regular coat of graſs; and this improvement will be effected the ſooner where the rivers are always muddied by the inundations from the mountains, and this always happens where the mountains are compoſed of argillaceous ſtrata. When the ſurface of ſuch portions of ſand are covered with a ſufficient coat of graſs, inſtead of being a nuiſance as formerly, they will then become of great uſe and value for paſture. Extenſive ſandy deſarts are generally ſituated between the tropics, or in warm climates, without them; and theſe ſands greatly increaſe the heat of ſuch climates; but where water can be ſpread over ſuch ſands, it is well known, that heat and moiſture encourage and increaſe vegetation; and, therefore, a few years would make a wonderful change on ſuch ſands. However, where they are covered with a coat of graſs, they muſt not be too ſoon, nor too raſhly deprived of all moiſture, leſt the heat of the climate in dry ſeaſons ſhould parch the ſurface, and endanger its being broken up again by the winds. The ſandy plains between the tropics will ſoon experience a ſurpriſing change of climate when laid under water. Inſtead of the burning heats which are now ſo intolerable and deſtructive, a plentiful and ſalubrious vapour will then be exhaled from an extenſive ſurface of water and humid ſand, which will cool the air, and make thoſe countries healthy, fertile, and pleaſant, which are now unſufferable, even to the raging blood of the lion and tiger, who are obliged to plunge into the rivers up to the noſtrils, or to retreat into the deep receſſes of gloomy caverns, during the heat of the day.

Deepening the rivers, draining the moraſſes, extirpating ſuperfluous foreſts, and flooding the ſands, with other proper and neceſſary improvements of the ground in the continent of Africa, would totally change the conſtitution of the climate and atmoſphere of that quarter of the globe. Such ſalutary improvements would be productive of wonderful revolutions in that great continent. It is generally known and allowed, that Africa is moſt conveniently ſituated for extenſive commerce; and that there is, in many of the known regions of that continent, a deep and excellent ſoil, tho' in moſt places either covered with wood, or ſteeping in moraſſes, or fermenting in the putrefying fruits of its own fertility, all of which produce ſuch an immenſity of noxious reptiles, inſects, and *animalculæ*, that the air and the waters are filled with them; and, of courſe, health,

plenty,

plenty, and happineſs are baniſhed, and will never viſit thoſe regions, while indolence and barbariſm bear ſo much ſway as at preſent.

Induſtry and good government, with an unity of deſign, among the ruling powers of that country, for the general good, would ſoon make it a paradiſe; but the foundation of ſuch happineſs muſt be laid by Europeans. Were Africa properly improved, many extenſive regions of it might vie with any part of the known world for the excellence and abundance of its productions, and for extenſive and proſperous commerce, and every human felicity.

The great importance of this ſubject is a ſufficient apology for my propoſing it.

If the nations and rulers of the world will not regard what ſuch an obſcure perſon ſays upon ſuch momentous topics, that is not my fault. I have done my duty.

But why ſhould I ſuſpect, that the beſt intentions, and moſt honeſt endeavours, ſhould be altogether loſt? Some good philoſopher may take notice of theſe ruſtic hints, aſſume the ſubject, and communicate it to the world in more ample form, and a better dreſs; and then others will be emulous to follow him, until at laſt it becomes as popular a ſubject as it is a fertile one; and there never was a ſubject of greater magnitude and importance, for the improvement and welfare of the world, propoſed by man.

There is no leſs propoſed than ſuch real and ſolid improvements of all parts of the world as are actually accompliſhed in China, and in ſome other places; and it is ſuppoſed, that theſe improvements would enable the earth to maintain near double the number of its preſent inhabitants, and that they would be much better maintained than multitudes are in the preſent unimproved ſtate of many countries; that by theſe improvements, the ſeveral communities on the ſame continent would be much better connected together, in mutual intercourſe, by the improvement of inland navigation; and that all nations would reciprocally reap the benefits of theſe improvements, by the multiplied means and conveniencies of enlarged commerce. And, to crown all, the extirpation of the ſuperfluous woods, deepening the rivers, and draining the moraſſes of the world, would bring about ſuch a total change of the climate and atmoſphere of all nations, that ſickneſs and pain would in a great meaſure be baniſhed from the children of men, when they would every where breathe a purer air, and enjoy a more wholeſome diet, the conſequences of which would be the enjoyment of firm health, longevity, and happineſs in all parts of the earth.

FINIS.

ERRATA.

VOL. II.

Page 8. line 19. *for* grilly, *read* gritty.

P. 58. l. 24. *for* from eaſt to weſt, *r.* from weſt to eaſt.

P. 91. l. 15. *for* grounds, *r.* ground.

P. 95. l. 3. *for* ſyſtem, *r.* ſyſtems.

P. 95. l. 17. *for* new earth, *r.* a new earth.

P. 112. l. 10. *r.* muſt ſubſide mixt and blended.

P. 125. l. 20. *for* about five, *r.* of about five.

P. 130. l. 21. *for* origin, *r.* organization.

P. 131. l. 19. *for* and upon, *r.* within and upon.

P. 135. l. 11. *for* real and partial, reſt at a height, *r.* real or partial.

P. 141. l. 17. *for* range, *r.* ranges.

P. 147. l. 8. *for* on an accurate, *r.* that on an accurate.

P. 204. l. 1. *for* depoſition, *r.* diſpoſition.

P. 289. l. 26. *for* the hunting of leopards, *r.* hunting leopards.

P. 332. l. 13. *for* being thrown out, *r.* thrown out.

P. 335. l. 9. *for* ſmall-pox as, *r.* ſmall-pox is.

P. 387. l. 19. *for* I have, *r.* I had.

P. 396. l. 13. *for* or variety, *r.* or vacuity.

P. 410. l. 7. for Ameer, *r.* Amur.

P. 469. l. 22. *for* theſe, *r.* that.

P. 469. l. 25. *for* impracticable, *r.* practicable.